US008064918B2

(12) **United States Patent**
Aiba et al.

(10) **Patent No.: US 8,064,918 B2**
(45) **Date of Patent: Nov. 22, 2011**

(54) **MOBILE COMMUNICATION SYSTEM, BASE STATION APPARATUS, AND MOBILE STATION APPARATUS**

(75) Inventors: **Tatsushi Aiba**, Osaka (JP); **Shohei Yamada**, Osaka (JP); **Hiroshi Katsuragawa**, Osaka (JP)

(73) Assignee: **Sharp Kabushiki Kaisha**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 85 days.

(21) Appl. No.: **12/555,593**

(22) Filed: **Sep. 8, 2009**

(65) **Prior Publication Data**

US 2009/0325619 A1 Dec. 31, 2009

Related U.S. Application Data

(62) Division of application No. 12/529,152, filed as application No. PCT/JP2008/060453 on Jun. 6, 2008.

(30) **Foreign Application Priority Data**

Jun. 8, 2007 (JP) 2007-152560

(51) **Int. Cl.**
H04W 72/00 (2009.01)
H04W 4/00 (2009.01)
H04B 7/00 (2006.01)

(52) **U.S. Cl.** **455/450**; 455/452.2; 455/509; 455/513; 370/329; 370/341

(58) **Field of Classification Search** 370/204, 370/206–207, 252–253, 310, 312, 328–330, 370/332–334, 341, 343–346, 348–349, 431, 370/436, 442, 468–469, 477–478, 487; 455/67.11, 455/422.1, 434, 450, 452.1–452.2, 509, 550.1, 455/556.2, 561, 423–425, 512–513, 517
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,871,066 B1 3/2005 Khullar et al.
6,993,294 B2 * 1/2006 Nobukiyo et al. 455/67.11
(Continued)

FOREIGN PATENT DOCUMENTS

EP 1916859 A1 4/1930
(Continued)

OTHER PUBLICATIONS

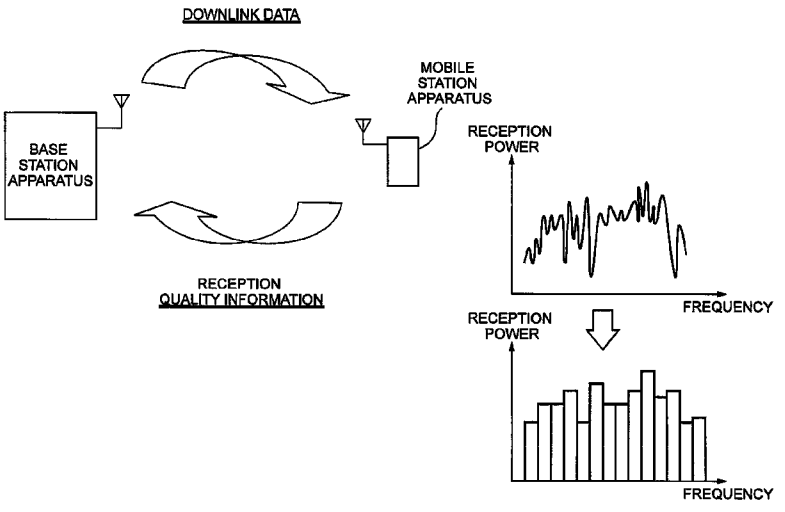
Russian Patent Application No. 2290764-C2, dated Dec. 27, 2008 (Abstract Only).
(Continued)

Primary Examiner — Meless Zewdu
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, uplink data using a physical uplink shared channel assigned by an uplink data transmission permission signal, wherein the base station apparatus: transmits, to the mobile station apparatus, a radio resource control signal including a transmission instruction of reception quality information; and transmits, to the mobile station apparatus, the uplink data transmission permission signal including a transmission instruction of reception quality information, and wherein the mobile station apparatus: periodically transmits, to the base station apparatus, first reception quality information according to a transmission instruction of the reception quality information included in the radio resource control signal; and transmits, to the base station apparatus, second reception quality information using the physical uplink shared channel in case that a transmission instruction of the reception quality information is included in the uplink data transmission permission signal.

6 Claims, 18 Drawing Sheets



U.S. PATENT DOCUMENTS

7,050,824	B2	5/2006	Masseroni et al.	
7,328,019	B2	2/2008	Nishikawa et al.	
7,352,709	B2	4/2008	Wakabayashi	
7,417,964	B2	8/2008	Cho et al.	
7,586,834	B2	9/2009	Byun et al.	
7,616,596	B2	11/2009	Lee et al.	
7,680,508	B2	3/2010	Liljestrom et al.	
7,693,170	B2	4/2010	Usuda et al.	
7,778,599	B2	8/2010	Li et al.	
7,809,373	B2	10/2010	Park et al.	
7,813,291	B2	10/2010	Yoon et al.	
7,817,605	B2	10/2010	Liu	
7,826,859	B2	11/2010	Lee et al.	
2001/0043576	A1	11/2001	Terry	
2004/0043783	A1	3/2004	Anderson	
2004/0242257	A1	12/2004	Valkealahti et al.	
2005/0233754	A1	10/2005	Beale	
2005/0243793	A1	11/2005	Kim et al.	
2006/0013185	A1	1/2006	Seo et al.	
2006/0058054	A1	3/2006	Hiramatsu	
2006/0092870	A1*	5/2006	Kondou et al.	370/318
2006/0211391	A1	9/2006	Nishikawa et al.	
2007/0076807	A1	4/2007	Jin et al.	
2007/0082619	A1	4/2007	Zhang et al.	
2007/0099647	A1	5/2007	Lee et al.	
2007/0153727	A1	7/2007	McBeath et al.	
2007/0254595	A1	11/2007	Yoon et al.	
2007/0265017	A1	11/2007	Ishii et al.	
2007/0270154	A1	11/2007	Kim et al.	
2007/0275728	A1	11/2007	Lohr et al.	
2008/0005639	A1	1/2008	Frederiksen	
2008/0064386	A1*	3/2008	Nibe	455/422.1
2008/0070610	A1	3/2008	Nishio	
2008/0207150	A1	8/2008	Malladi et al.	
2008/0212506	A1*	9/2008	Lee et al.	370/310
2008/0268785	A1	10/2008	McCoy et al.	
2008/0287138	A1	11/2008	Yoon et al.	
2008/0316961	A1	12/2008	Bertrand et al.	
2009/0034505	A1	2/2009	Papasakellariou et al.	
2009/0180414	A1*	7/2009	Maeda et al.	370/311
2009/0185577	A1	7/2009	Kishiyama et al.	
2009/0190528	A1	7/2009	Chung et al.	
2009/0201885	A1	8/2009	Kuroda et al.	
2009/0215464	A1	8/2009	Tanno et al.	
2009/0238121	A1	9/2009	Kotecha	
2009/0238241	A1	9/2009	Hooli et al.	
2009/0305715	A1*	12/2009	Barve et al.	455/452.2
2009/0316633	A1*	12/2009	Kato et al.	370/329
2010/0103833	A1	4/2010	Englund et al.	
2010/0113057	A1	5/2010	Englund et al.	
2010/0173638	A1	7/2010	Aiba et al.	
2010/0183086	A1	7/2010	Ko et al.	
2010/0284326	A1*	11/2010	Oh	370/328

FOREIGN PATENT DOCUMENTS

EP	1526674	A1	4/2005
EP	1811690	A1	7/2007
EP	1871028	A1	12/2007
EP	1892975	A1	2/2008
JP	2003-510893	A	3/2003
JP	2003-199173	A	7/2003
JP	2005-130491	A	5/2005
JP	2005-237005	A	9/2005
JP	2006-262077	A	9/2006
JP	2006-352382	A	12/2006
JP	2007-124662	A	5/2007
RU	2108670	C1	4/1998
RU	2290764	C2	12/2006
WO	WO 2005/072073	A2	8/2005
WO	WO 2005/122616	A1	12/2005
WO	WO 2006/043712	A1	4/2006
WO	WO 2006/109436	A1	10/2006
WO	WO 2006/109646	A1	10/2006
WO	WO 2007/013457	A1	2/2007
WO	WO 2008/115110	A1	9/2008

OTHER PUBLICATIONS

Notice of Allowance issued in U.S. Appl. No. 12/529,152 on Jul. 26, 2011.

Notice of Allowance issued in U.S. Appl. No. 12/555,566 on Jul. 18, 2011.

"3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Layer procedures (Release 8)," 3GPP Ts 36.213 v8.0.0, XP 05077555, pp. 1-14, Sep. 1, 2007.

Extended European Search Report, dated Feb. 2, 2011, for European Application No. 08829634.8.

IPWIRELESS, "CQI reporting and resource allocation for CQI reporting w.r.t. DRX level," 3GPP TSG RAN WG2 #57bis, XP050134358, 3 pages, R2-071419, Mar. 26-30, 2007.

Supplementary European Search Report, dated Jan. 12, 2011, for European Application No. 08765266.5.

U.S. Office Action, dated Apr. 15, 2011, for U.S. Appl. No. 12/555,578.

U.S. Office Action, dated Apr. 5, 2011, for U.S. Appl. No. 12/461,988.

U.S. Office Action, dated Dec. 10, 2010, for U.S. Appl. No. 12/461,986.

U.S. Office Action, dated Dec. 13, 2010, for U.S. Appl. No. 12/461,988.

U.S. Office Action, dated Dec. 13, 2010, for U.S. Appl. No. 12/529,042.

U.S. Office Action, dated Dec. 9, 2010, for U.S. Appl. No. 12/461,987.

U.S. Office Action, dated Jan. 19, 2011, for U.S. Appl. No. 12/555,566.

U.S. Office Action, dated Jan. 21, 2011, for U.S. Appl. No. 12/529,152.

U.S. Office Action, dated Jan. 26, 2011, for U.S. Appl. No. 12/461,986.

U.S. Office Action, dated Jan. 27, 2011, for U.S. Appl. No. 12/461,987.

U.S. Office Action, dated Jul. 8, 2011, for U.S. Appl. No. 12/529,042.

U.S. Office Action, dated Jun. 13, 2011, for U.S. Appl. No. 12/461,988 (Advisory Action).

U.S. Office Action, dated Jun. 24, 2011, for U.S. Appl. No. 12/461,987.

U.S. Office Action, dated Oct. 14, 2010, for U.S. Appl. No. 12/529,152.

European Search Report issued in European Patent Application No. EP 09 01 1158 on Aug. 4, 2011.

European Search Report issued in European Patent Application No. EP 09 01 1159 on Aug. 4, 2011.

European Search Report issued in European Patent Application No. EP 09 01 1160 on Aug. 4, 2011.

U.S. Office Action issued in U.S. Appl. No. 12/461,988 on Aug. 17, 2011.

European Search Report issued in European Patent Application No. EP 09 01 1162 on Aug. 19, 2011.

European Search Report issued in European Patent Application No. EP 09 01 1163 on Aug. 19, 2011.

European Search Report issued in European Patent Application No. EP 09 01 1164 on Aug. 19, 2011.

Benq Mobile, "Dynamic control of CQI reporting," 3GPP TSG RAN WG2 #54, Tallinn, Estonia, Aug. 28-Sep. 1, 2006, R2-062448, 5 pages.

Ericsson, "E-UTRA Intra-frequency Measurement Configuration and Control," 3GPP TSG-RAN WG2 Meeting #56, Riga, Latvia, Nov. 6-10, 2006, R2-063228, 4 pages.

LG Electronics, "Issue on periodic measurement reporting," 3GPP TSG RAN WG2 #57bis, St. Julian's, Malta, Mar. 26-30, 2007, Tdoc R2-071448, pp. 1-3.

Samsung, "CQI handling during DRX," 3GPP TSG-RAN2 Meeting #58, Kobe, Japan, May 7-11, 2007, Tdoc R2-071901, pp. 1-4.

Shrcwc, "A new format of UL scheduling grant signaling for E-UTRA," 3GPP TSG-RAN WG2 #55, Seoul, Korea, Oct. 9-12, 2006, R2-06xxxx, pp. 1-5.

* cited by examiner

FIG. 1

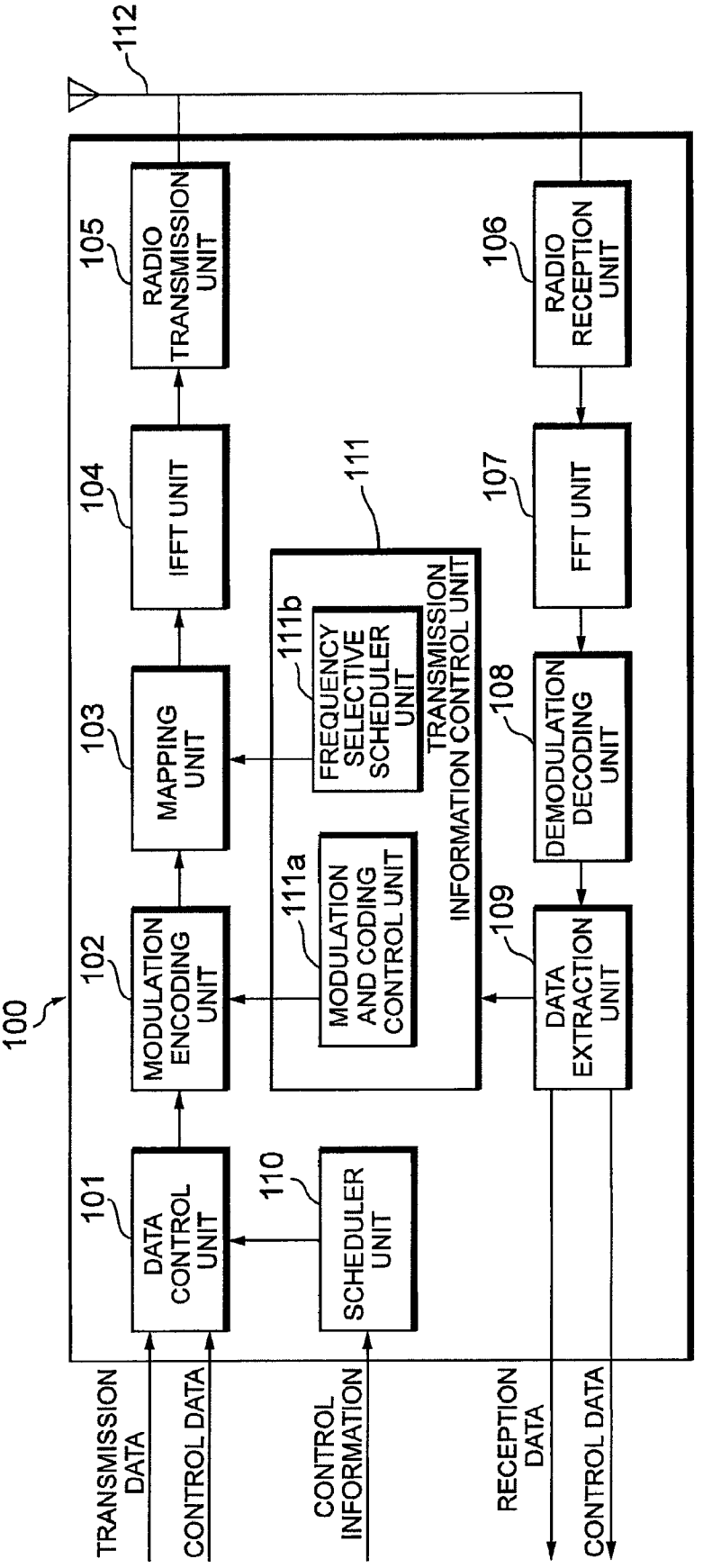

100
101
DATA CONTROL UNIT
102
MODULATION ENCODING UNIT
103
MAPPING UNIT
104
IFFT UNIT
105
RADIO TRANSMISSION UNIT
106
RADIO RECEPTION UNIT
107
FFT UNIT
108
DEMODULATION DECODING UNIT
109
DATA EXTRACTION UNIT
110
SCHEDULER UNIT
111
TRANSMISSION INFORMATION CONTROL UNIT
111a
MODULATION AND CODING CONTROL UNIT
111b
FREQUENCY SELECTIVE SCHEDULER UNIT
112
TRANSMISSION DATA
CONTROL DATA
CONTROL INFORMATION
RECEPTION DATA
CONTROL DATA

FIG. 2

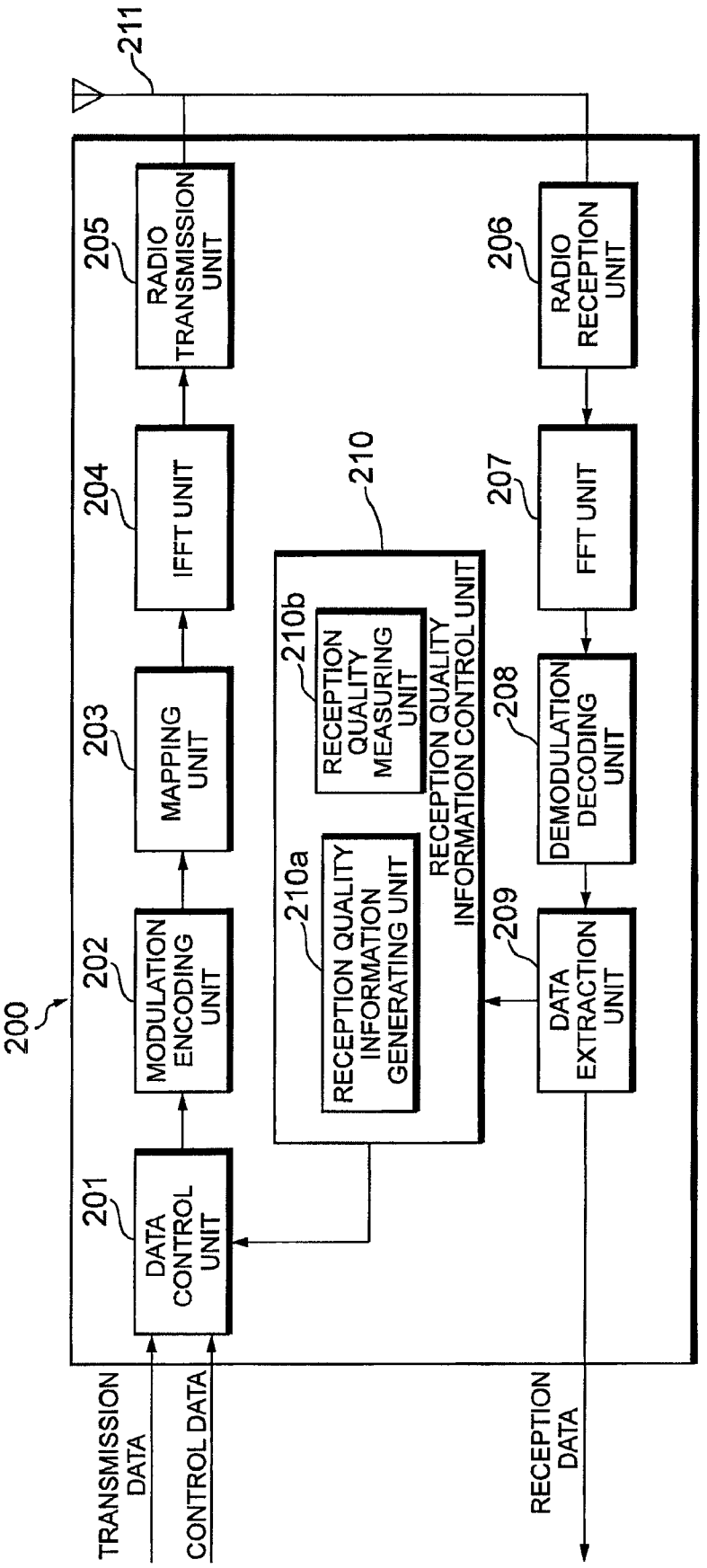

211
205
RADIO TRANSMISSION UNIT
206
RADIO RECEPTION UNIT
204
IFFT UNIT
207
FFT UNIT
210
210b
RECEPTION QUALITY MEASURING UNIT
203
MAPPING UNIT
208
DEMODULATION DECODING UNIT
RECEPTION QUALITY INFORMATION CONTROL UNIT
210a
RECEPTION QUALITY INFORMATION GENERATING UNIT
202
MODULATION ENCODING UNIT
209
DATA EXTRACTION UNIT
200
201
DATA CONTROL UNIT
TRANSMISSION DATA
CONTROL DATA
RECEPTION DATA

FIG. 3

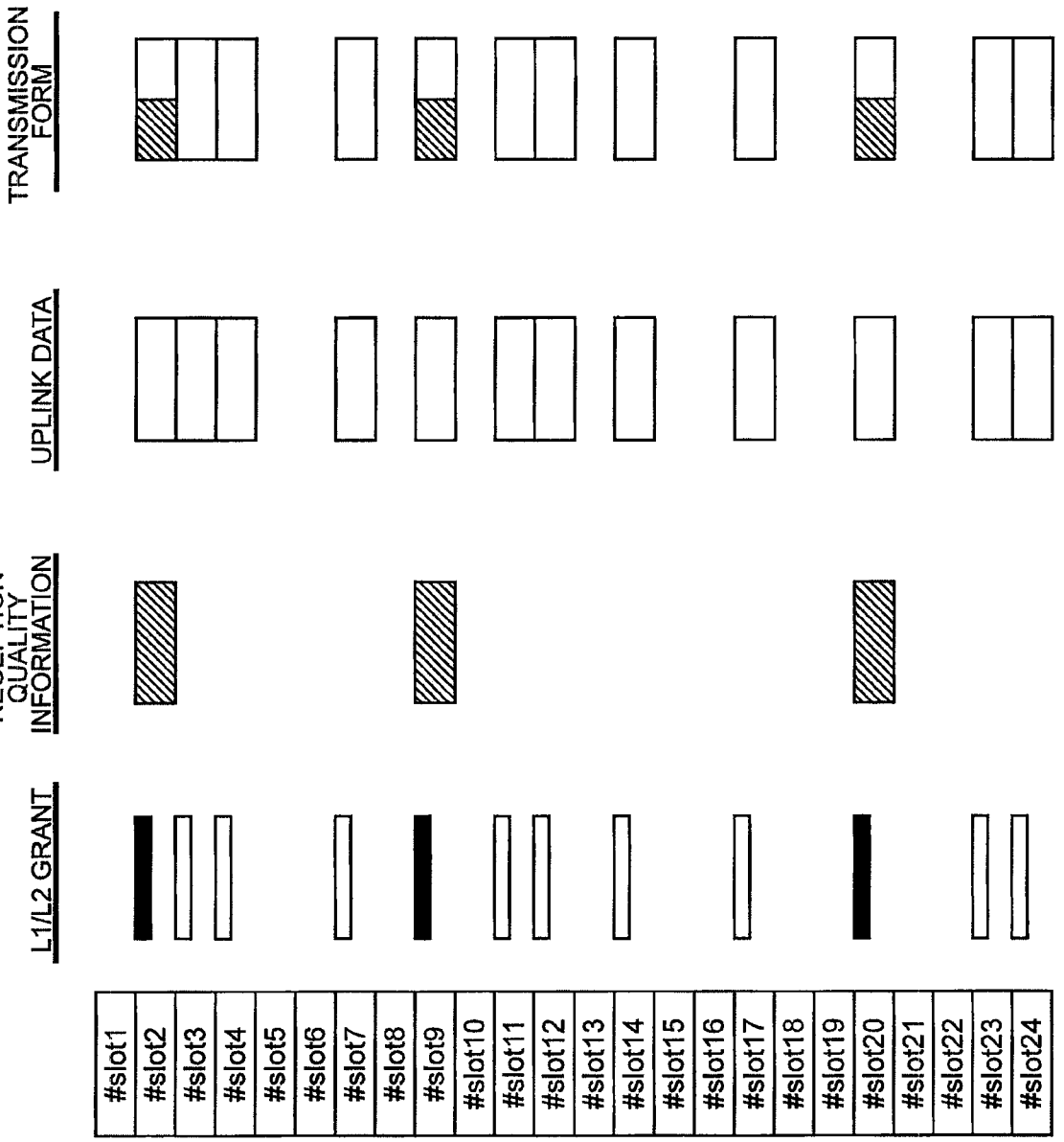

L1/L2 GRANT
RECEPTION QUALITY INFORMATION
UPLINK DATA
TRANSMISSION FORM
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12
#slot13
#slot14
#slot15
#slot16
#slot17
#slot18
#slot19
#slot20
#slot21
#slot22
#slot23
#slot24

FIG. 4

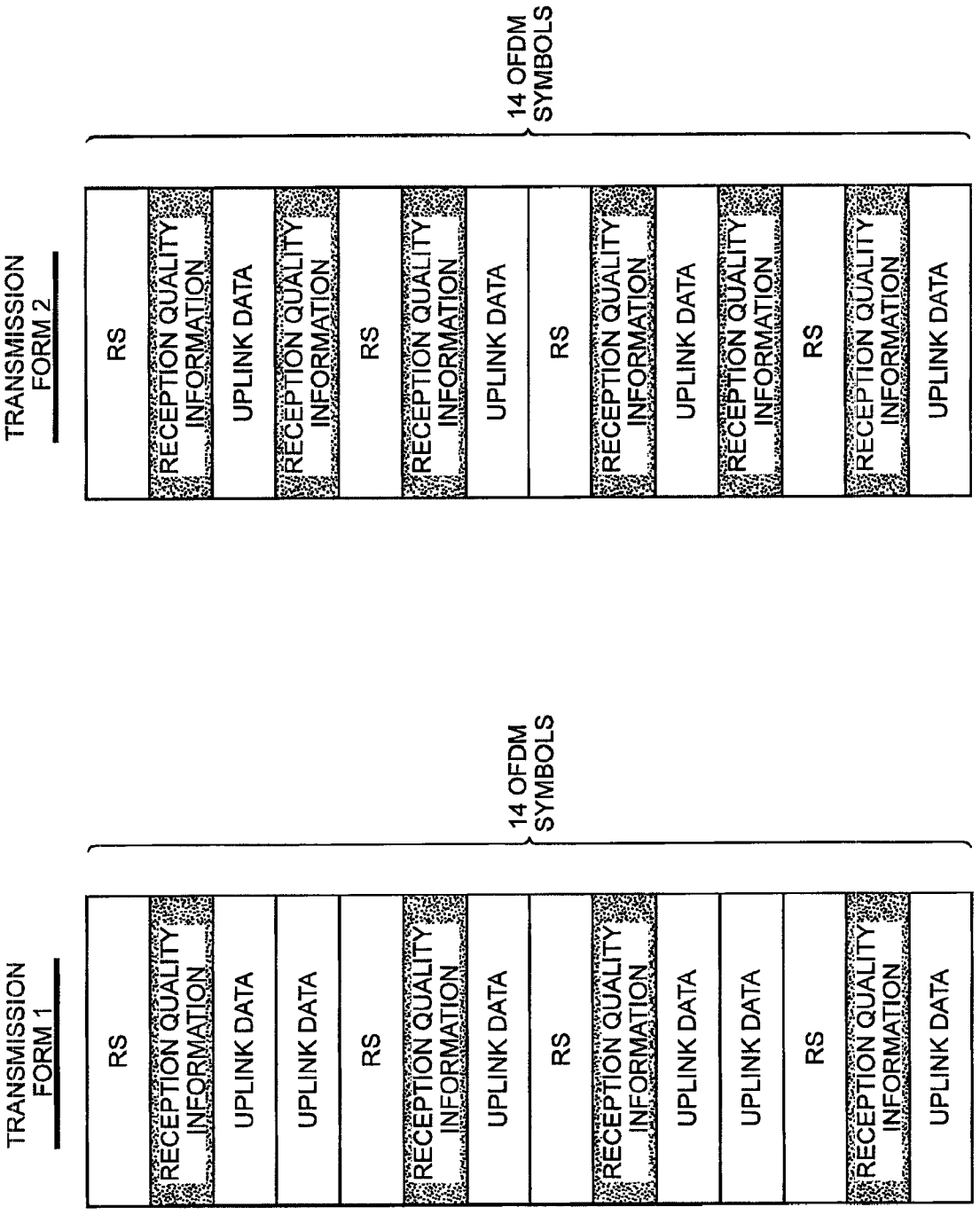

TRANSMISSION FORM 1
14 OFDM SYMBOLS
RS
RECEPTION QUALITY INFORMATION
UPLINK DATA
UPLINK DATA
RS
RECEPTION QUALITY INFORMATION
UPLINK DATA
RS
RECEPTION QUALITY INFORMATION
UPLINK DATA
UPLINK DATA
RS
RECEPTION QUALITY INFORMATION
UPLINK DATA
TRANSMISSION FORM 2
14 OFDM SYMBOLS
RS
RECEPTION QUALITY INFORMATION
UPLINK DATA
RECEPTION QUALITY INFORMATION
RS
RECEPTION QUALITY INFORMATION
UPLINK DATA
RS
RECEPTION QUALITY INFORMATION
UPLINK DATA
RECEPTION QUALITY INFORMATION
RS
RECEPTION QUALITY INFORMATION
UPLINK DATA

FIG. 5

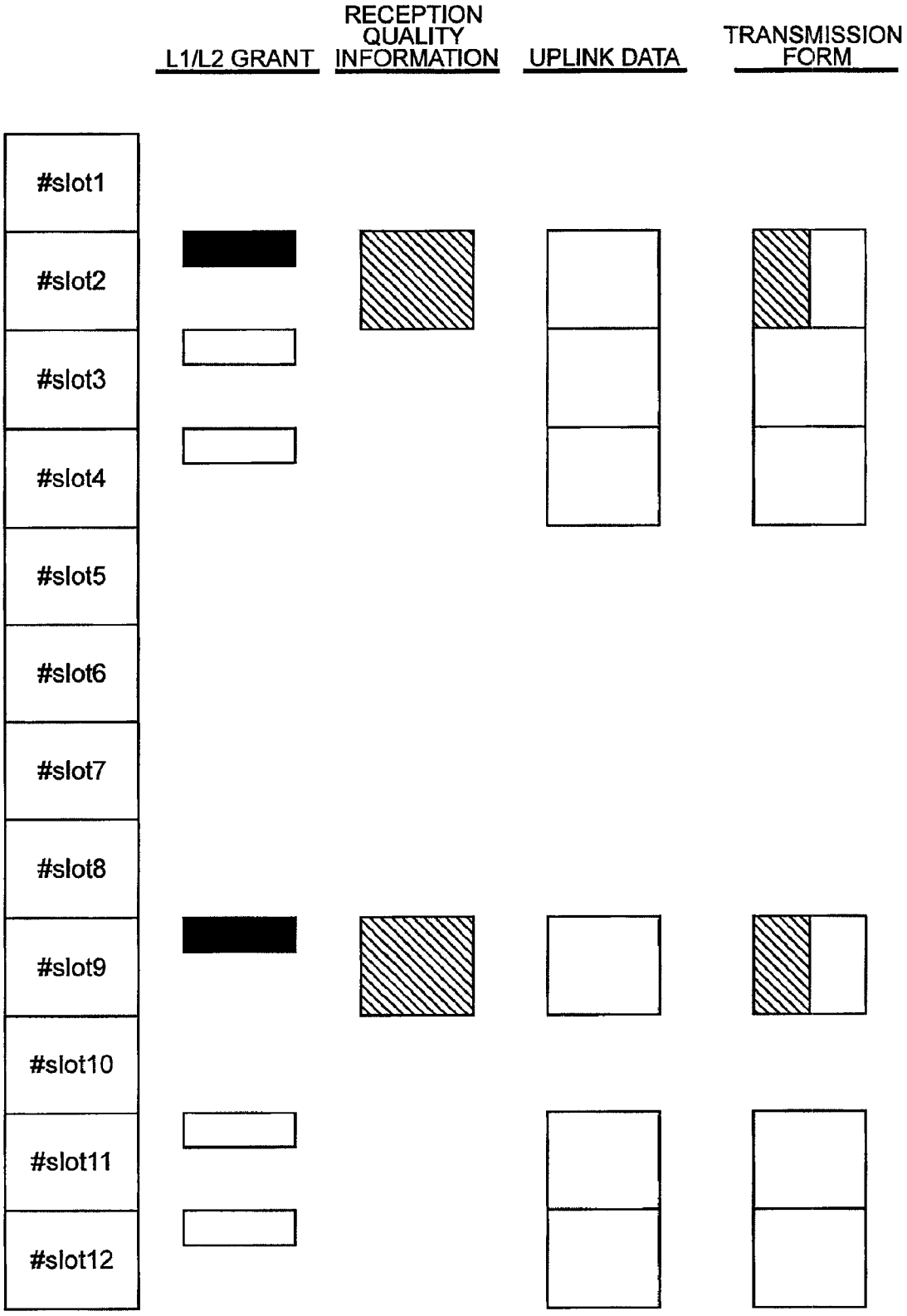

L1/L2 GRANT
RECEPTION QUALITY INFORMATION
UPLINK DATA
TRANSMISSION FORM
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12

FIG. 6

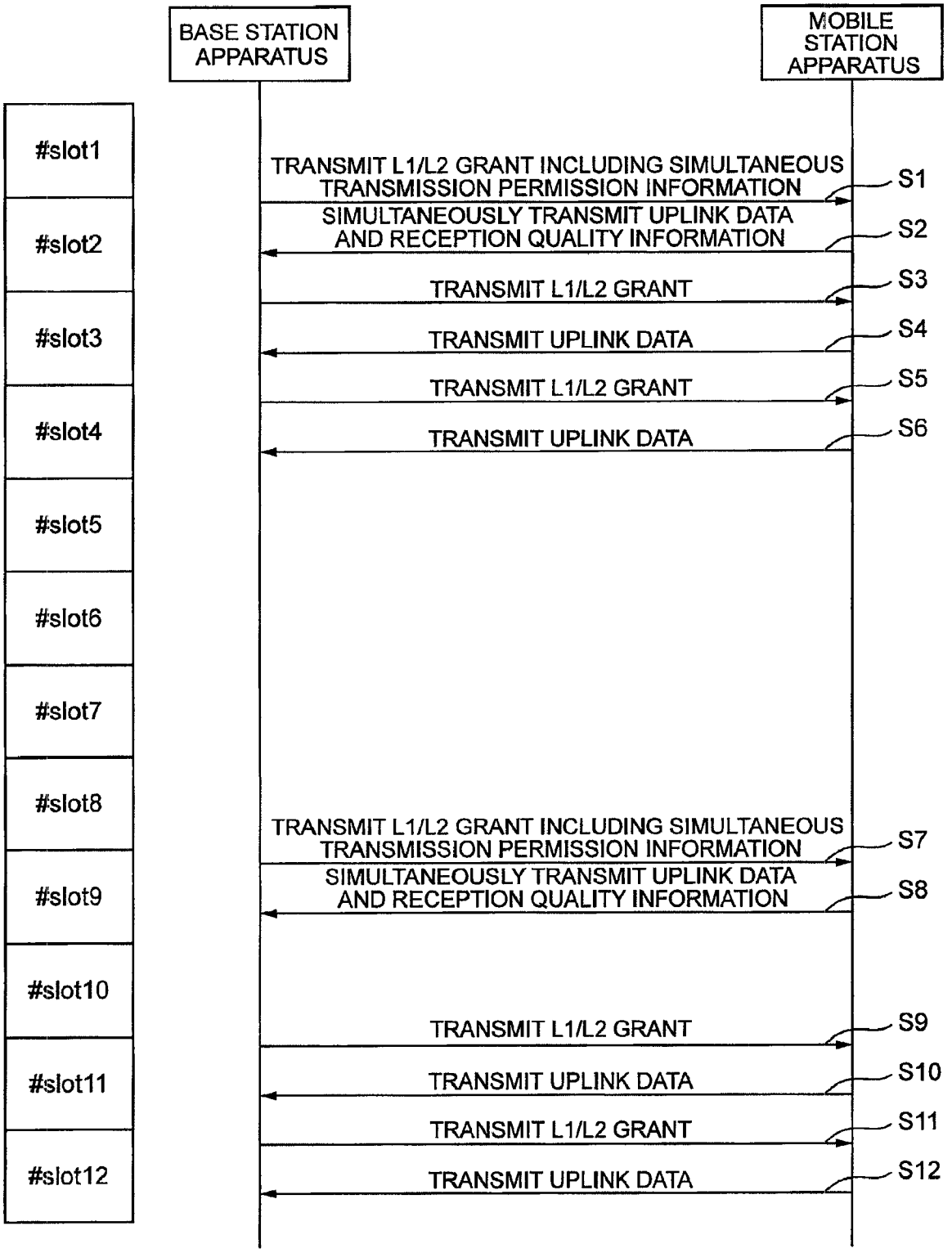

BASE STATION APPARATUS
MOBILE STATION APPARATUS
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12
TRANSMIT L1/L2 GRANT INCLUDING SIMULTANEOUS TRANSMISSION PERMISSION INFORMATION
S1
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S2
TRANSMIT L1/L2 GRANT
S3
TRANSMIT UPLINK DATA
S4
TRANSMIT L1/L2 GRANT
S5
TRANSMIT UPLINK DATA
S6
TRANSMIT L1/L2 GRANT INCLUDING SIMULTANEOUS TRANSMISSION PERMISSION INFORMATION
S7
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S8
TRANSMIT L1/L2 GRANT
S9
TRANSMIT UPLINK DATA
S10
TRANSMIT L1/L2 GRANT
S11
TRANSMIT UPLINK DATA
S12

FIG. 7

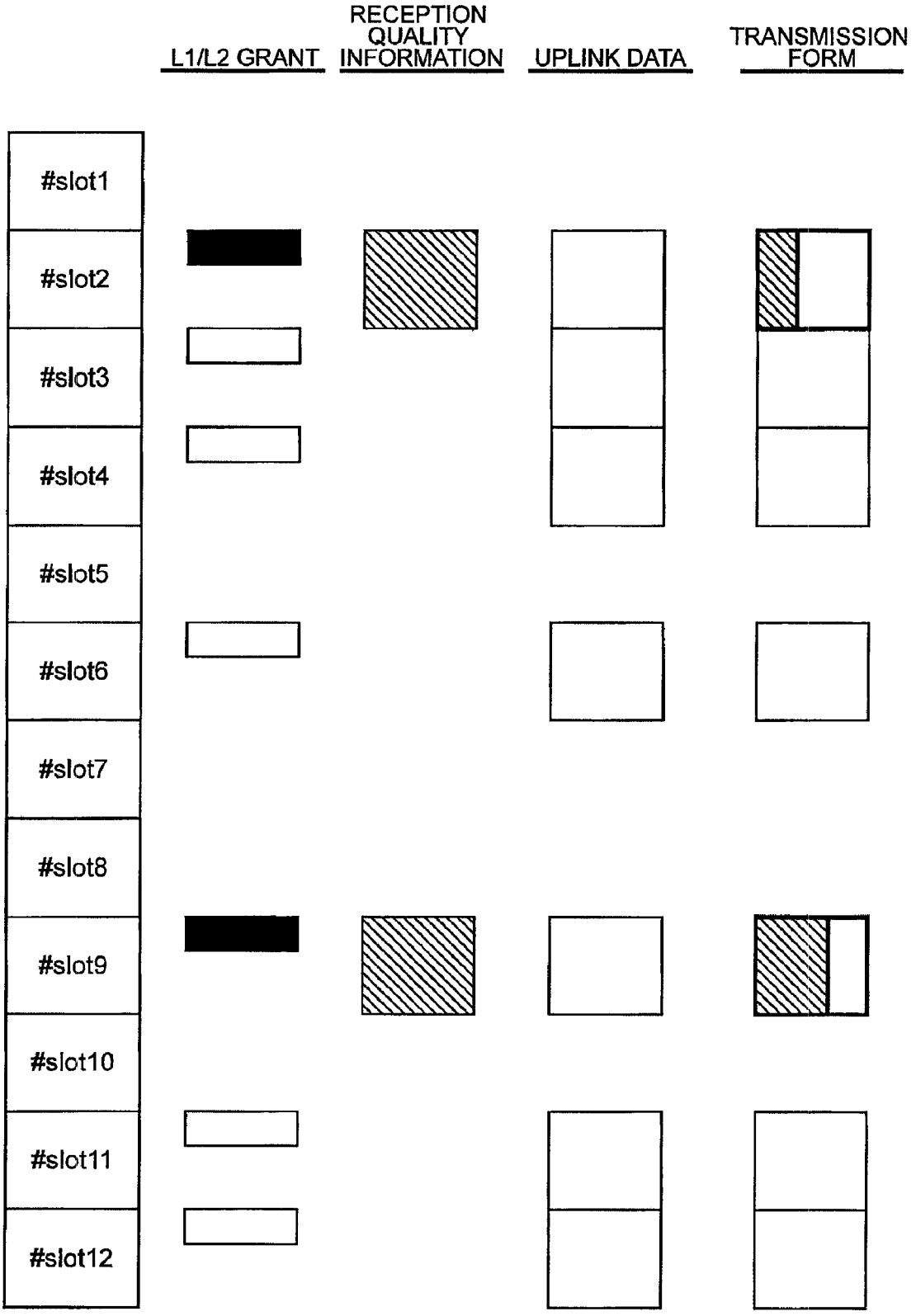

L1/L2 GRANT
RECEPTION QUALITY INFORMATION
UPLINK DATA
TRANSMISSION FORM
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12

FIG. 8

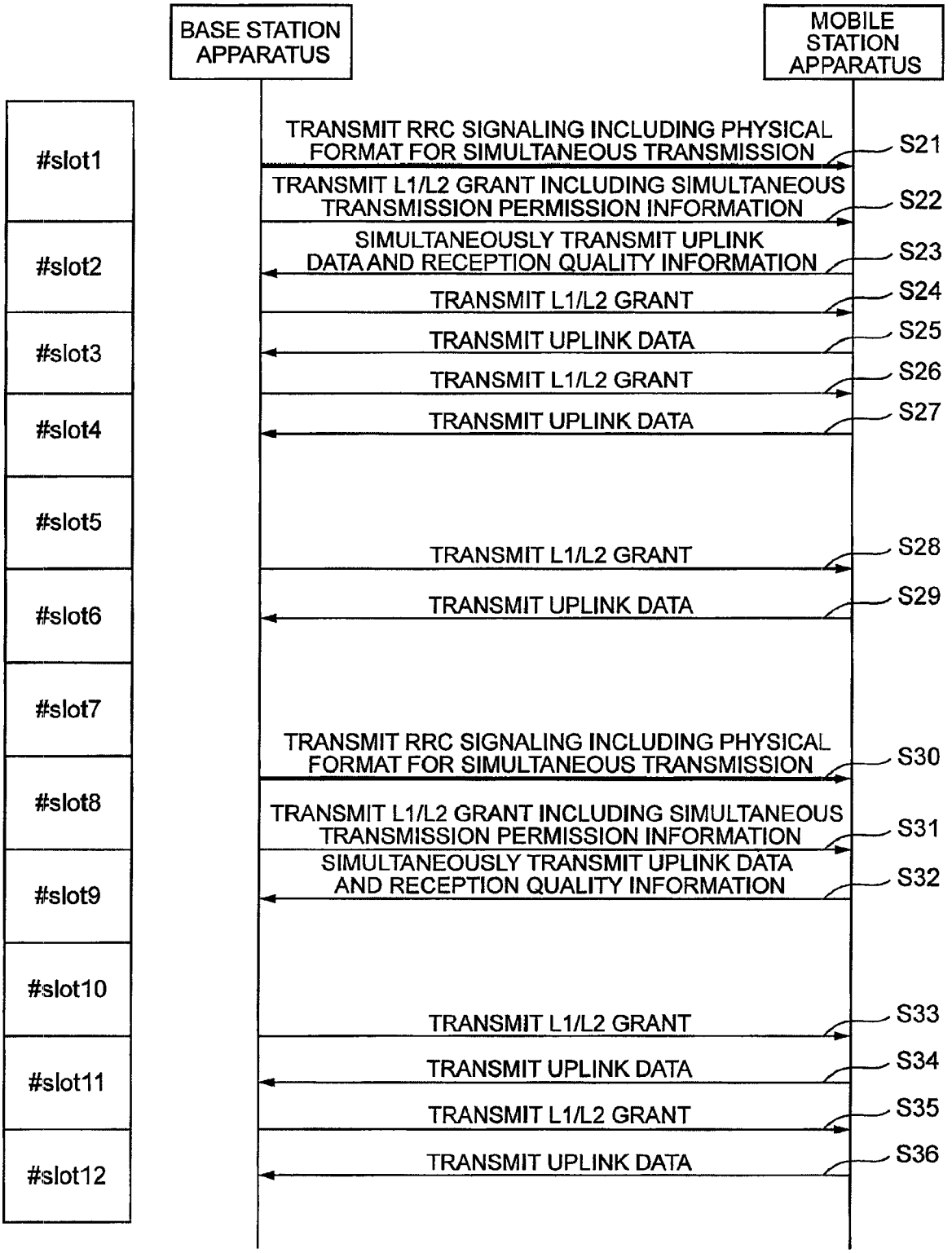

BASE STATION APPARATUS
MOBILE STATION APPARATUS
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12
TRANSMIT RRC SIGNALING INCLUDING PHYSICAL FORMAT FOR SIMULTANEOUS TRANSMISSION
S21
TRANSMIT L1/L2 GRANT INCLUDING SIMULTANEOUS TRANSMISSION PERMISSION INFORMATION
S22
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S23
TRANSMIT L1/L2 GRANT
S24
TRANSMIT UPLINK DATA
S25
TRANSMIT L1/L2 GRANT
S26
TRANSMIT UPLINK DATA
S27
TRANSMIT L1/L2 GRANT
S28
TRANSMIT UPLINK DATA
S29
TRANSMIT RRC SIGNALING INCLUDING PHYSICAL FORMAT FOR SIMULTANEOUS TRANSMISSION
S30
TRANSMIT L1/L2 GRANT INCLUDING SIMULTANEOUS TRANSMISSION PERMISSION INFORMATION
S31
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S32
TRANSMIT L1/L2 GRANT
S33
TRANSMIT UPLINK DATA
S34
TRANSMIT L1/L2 GRANT
S35
TRANSMIT UPLINK DATA
S36

FIG. 9

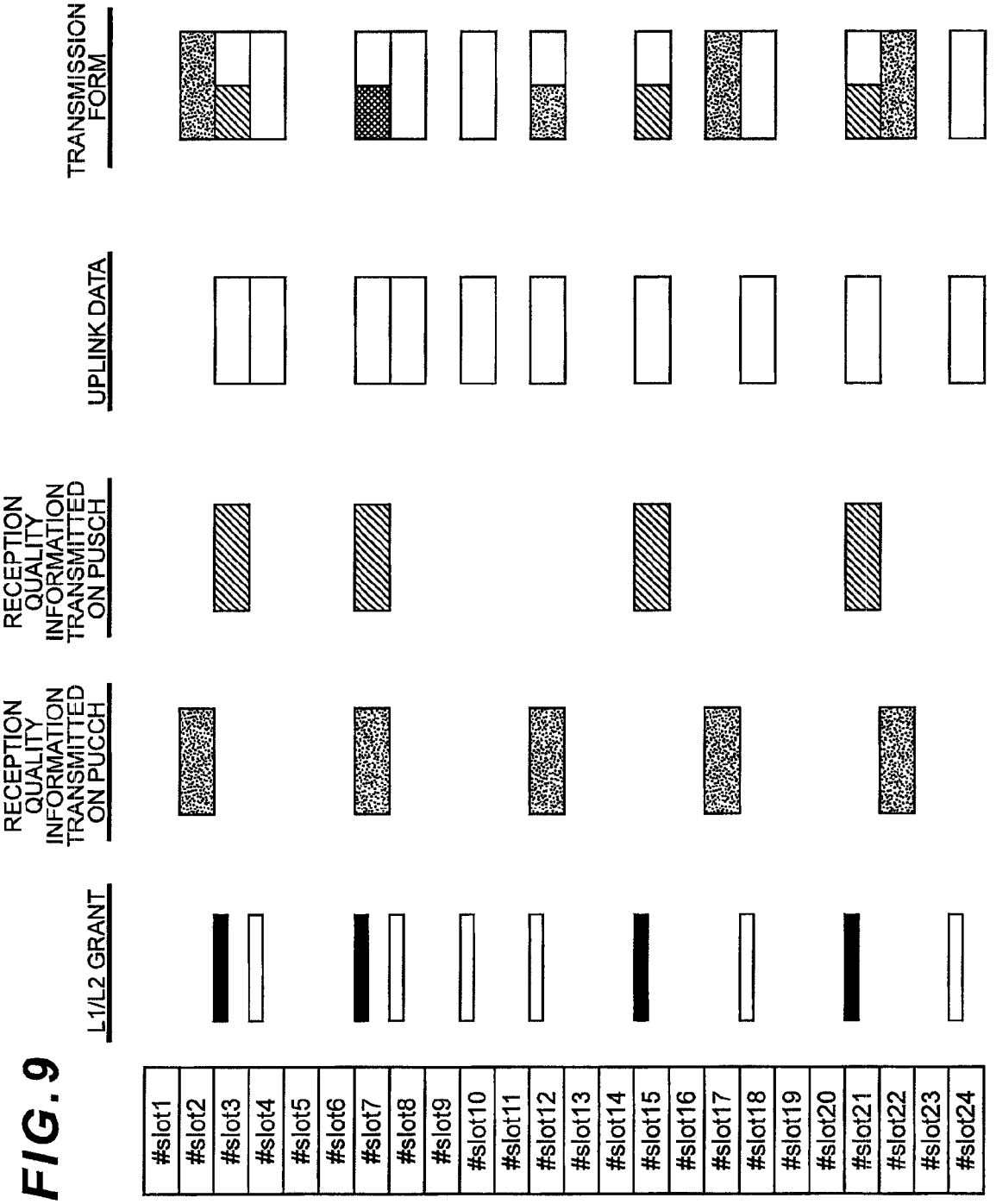

#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12
#slot13
#slot14
#slot15
#slot16
#slot17
#slot18
#slot19
#slot20
#slot21
#slot22
#slot23
#slot24
L1/L2 GRANT
RECEPTION QUALITY INFORMATION TRANSMITTED ON PUCCH
RECEPTION QUALITY INFORMATION TRANSMITTED ON PUSCH
UPLINK DATA
TRANSMISSION FORM

FIG. 10

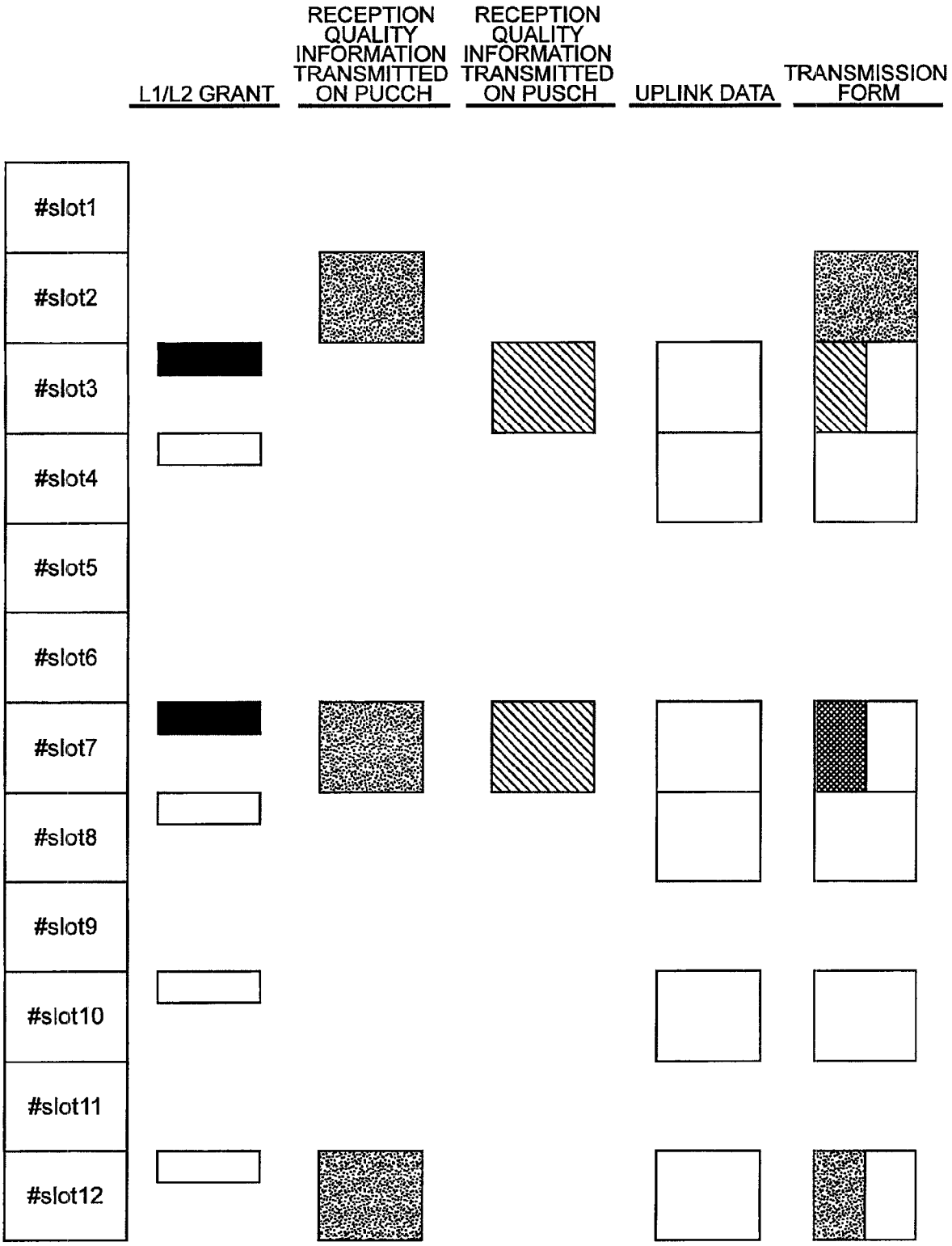

L1/L2 GRANT
RECEPTION QUALITY INFORMATION TRANSMITTED ON PUCCH
RECEPTION QUALITY INFORMATION TRANSMITTED ON PUSCH
UPLINK DATA
TRANSMISSION FORM
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12

FIG. 11

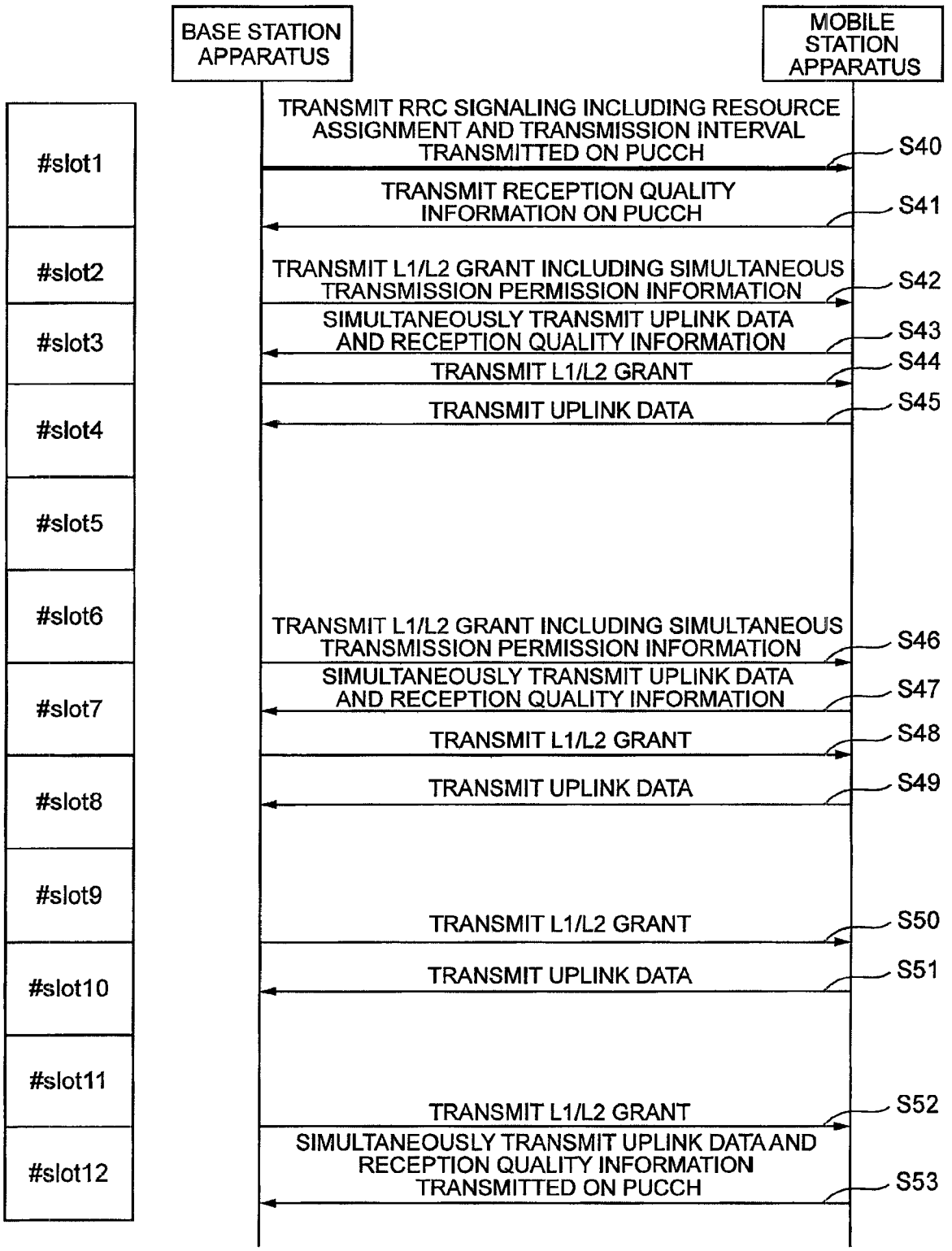

BASE STATION APPARATUS
MOBILE STATION APPARATUS
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12
TRANSMIT RRC SIGNALING INCLUDING RESOURCE ASSIGNMENT AND TRANSMISSION INTERVAL TRANSMITTED ON PUCCH
S40
TRANSMIT RECEPTION QUALITY INFORMATION ON PUCCH
S41
TRANSMIT L1/L2 GRANT INCLUDING SIMULTANEOUS TRANSMISSION PERMISSION INFORMATION
S42
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S43
TRANSMIT L1/L2 GRANT
S44
TRANSMIT UPLINK DATA
S45
TRANSMIT L1/L2 GRANT INCLUDING SIMULTANEOUS TRANSMISSION PERMISSION INFORMATION
S46
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S47
TRANSMIT L1/L2 GRANT
S48
TRANSMIT UPLINK DATA
S49
TRANSMIT L1/L2 GRANT
S50
TRANSMIT UPLINK DATA
S51
TRANSMIT L1/L2 GRANT
S52
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION TRANSMITTED ON PUCCH
S53

FIG. 12

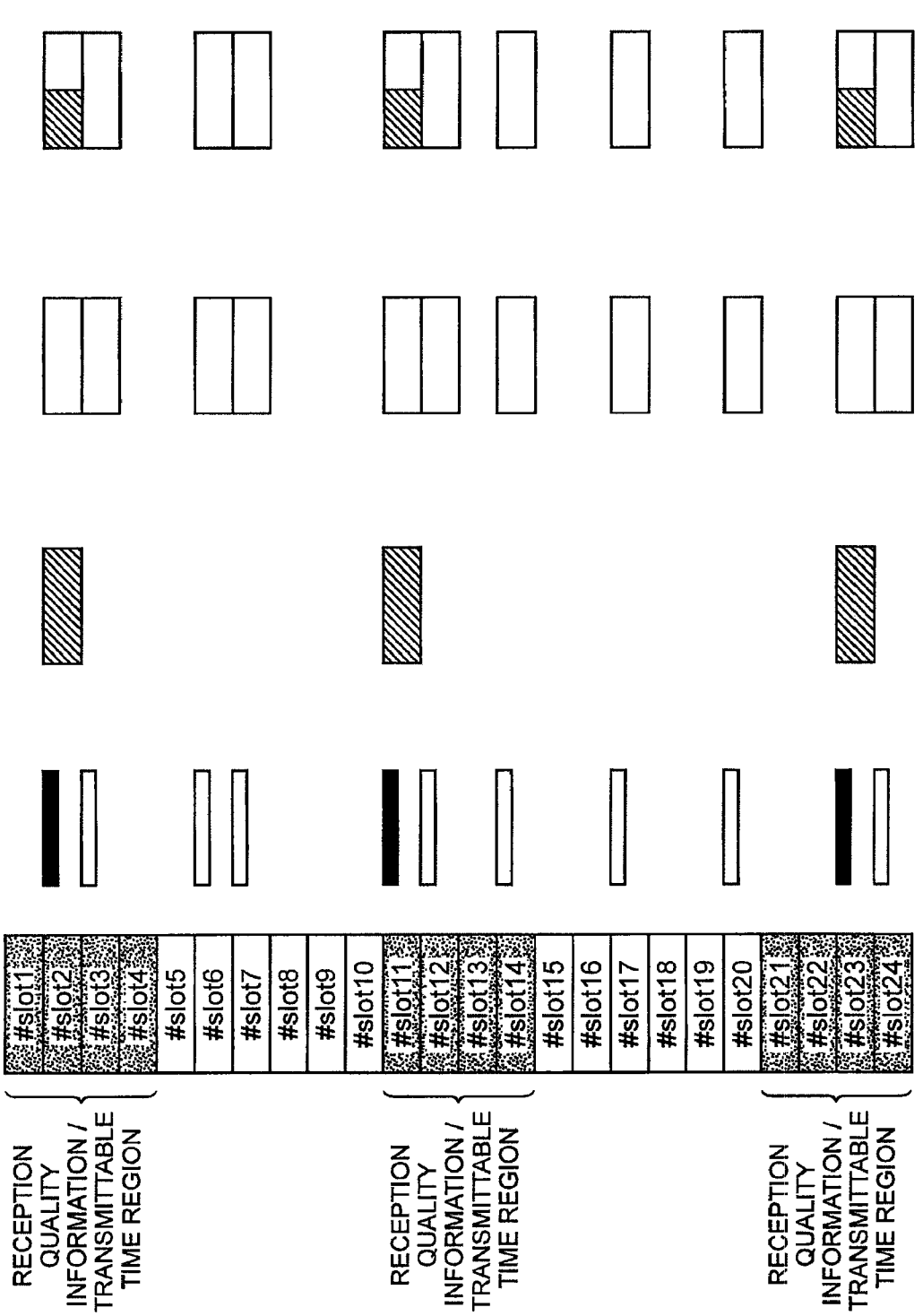

L1/L2 GRANT
RECEPTION QUALITY INFORMATION
UPLINK DATA
TRANSMISSION FORM
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12
#slot13
#slot14
#slot15
#slot16
#slot17
#slot18
#slot19
#slot20
#slot21
#slot22
#slot23
#slot24
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION

FIG. 13

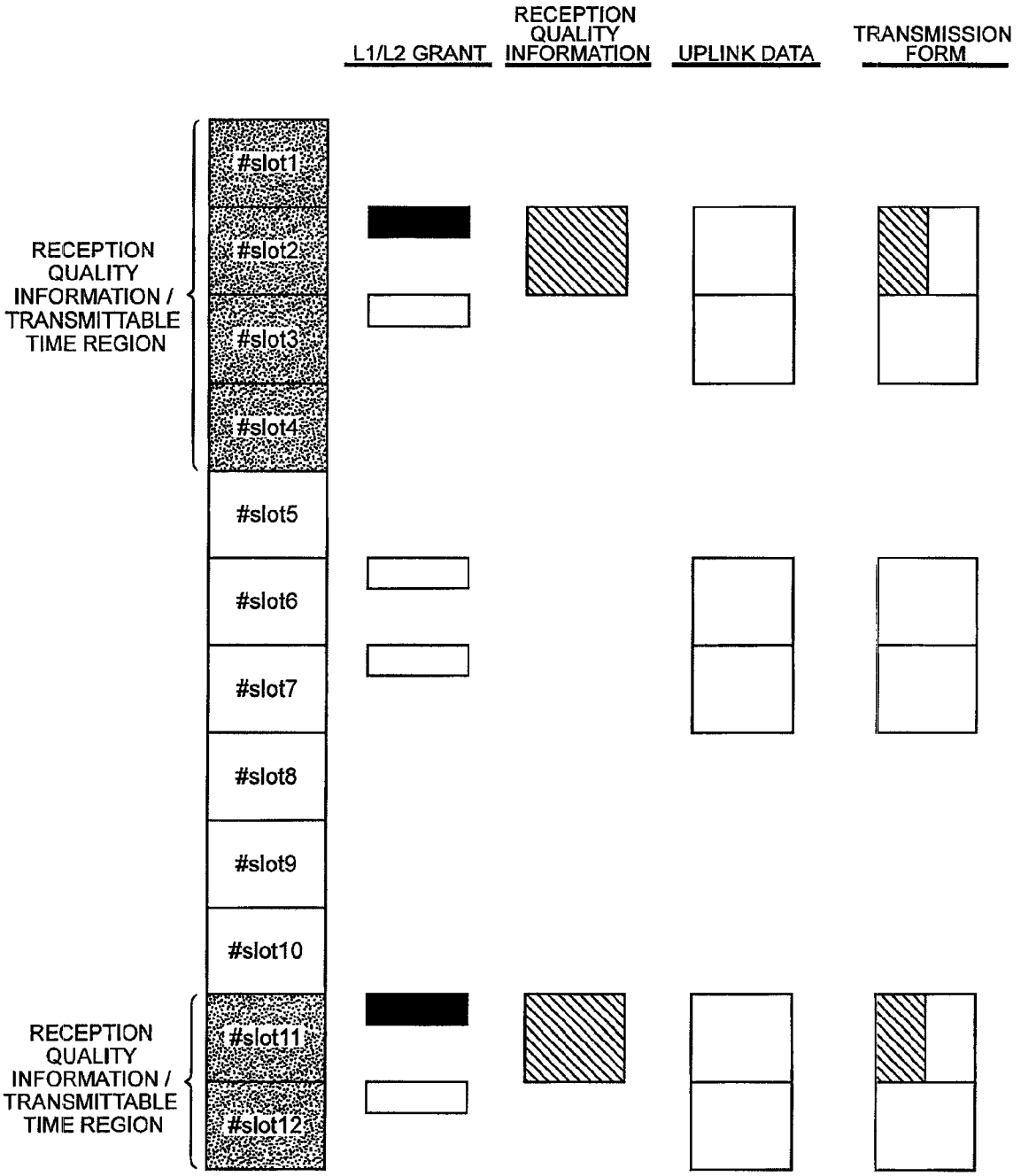

L1/L2 GRANT
RECEPTION QUALITY INFORMATION
UPLINK DATA
TRANSMISSION FORM
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
#slot11
#slot12

FIG. 14

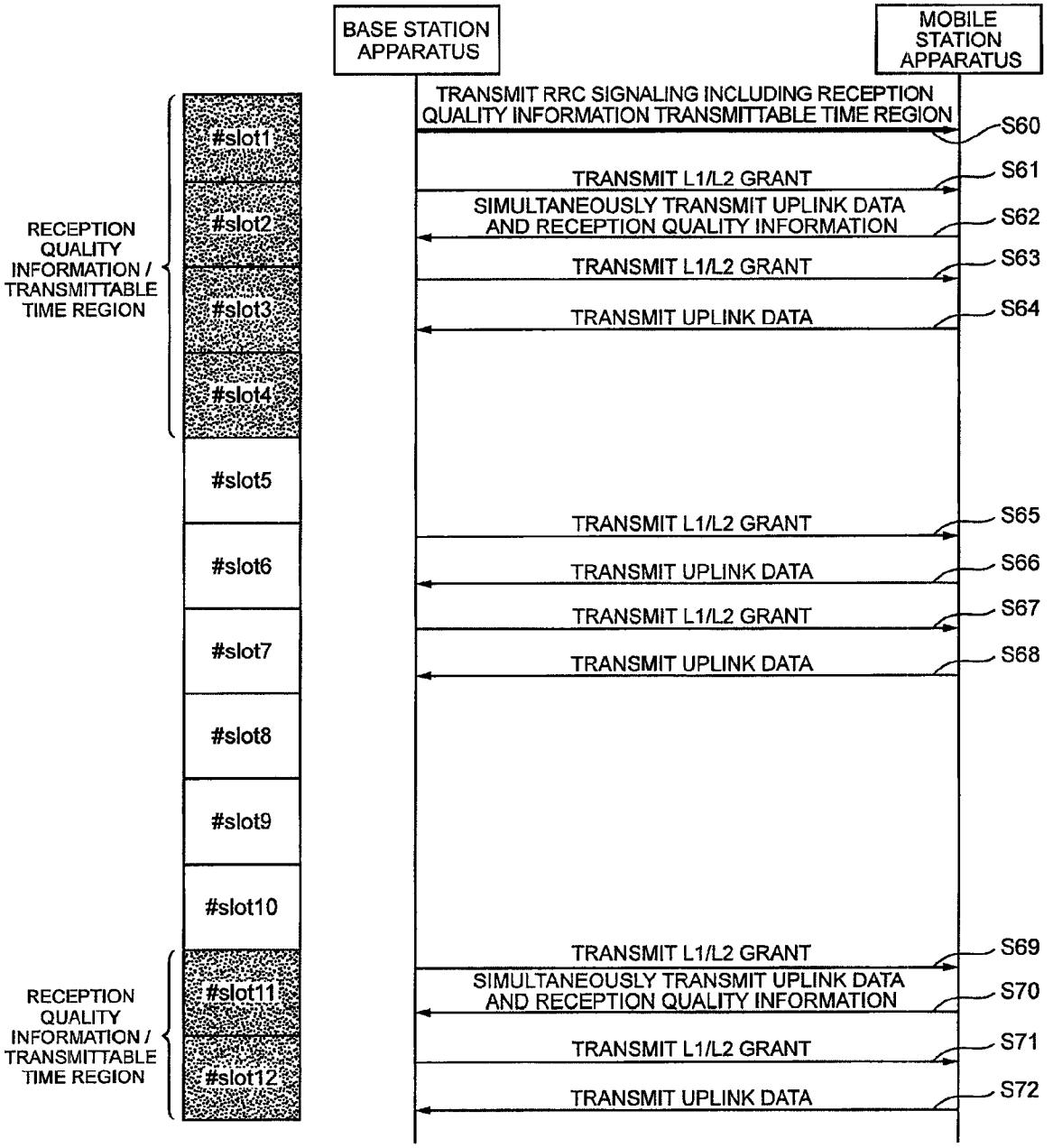

BASE STATION APPARATUS
MOBILE STATION APPARATUS
TRANSMIT RRC SIGNALING INCLUDING RECEPTION QUALITY INFORMATION TRANSMITTABLE TIME REGION
S60
TRANSMIT L1/L2 GRANT
S61
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S62
TRANSMIT L1/L2 GRANT
S63
TRANSMIT UPLINK DATA
S64
TRANSMIT L1/L2 GRANT
S65
TRANSMIT UPLINK DATA
S66
TRANSMIT L1/L2 GRANT
S67
TRANSMIT UPLINK DATA
S68
TRANSMIT L1/L2 GRANT
S69
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S70
TRANSMIT L1/L2 GRANT
S71
TRANSMIT UPLINK DATA
S72
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
#slot11
#slot12

FIG. 15

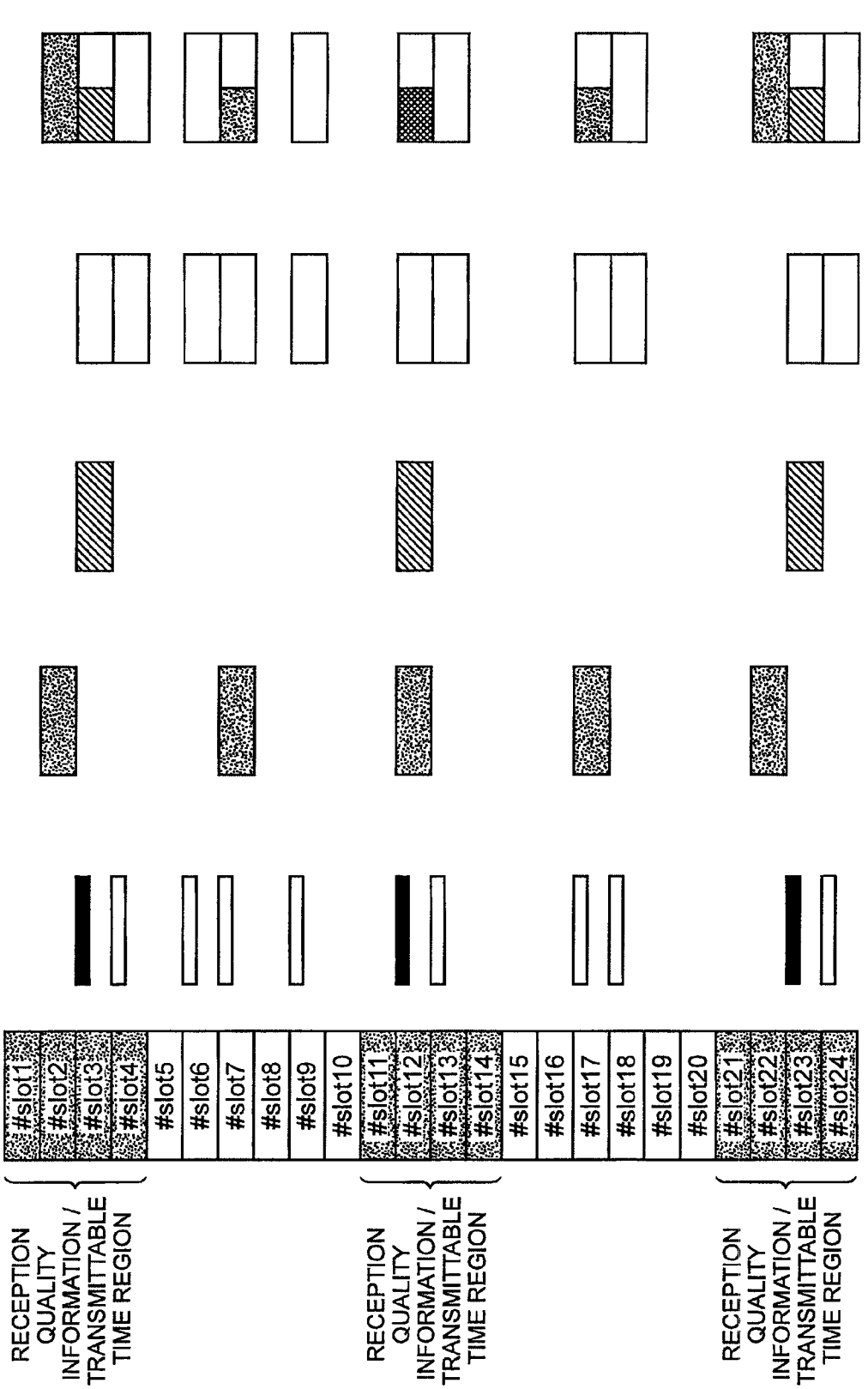

L1/L2 GRANT
RECEPTION QUALITY INFORMATION TRANSMITTED ON PUCCH
RECEPTION QUALITY INFORMATION TRANSMITTED ON PUSCH
UPLINK DATA
TRANSMISSION FORM
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12
#slot13
#slot14
#slot15
#slot16
#slot17
#slot18
#slot19
#slot20
#slot21
#slot22
#slot23
#slot24
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION

FIG. 16

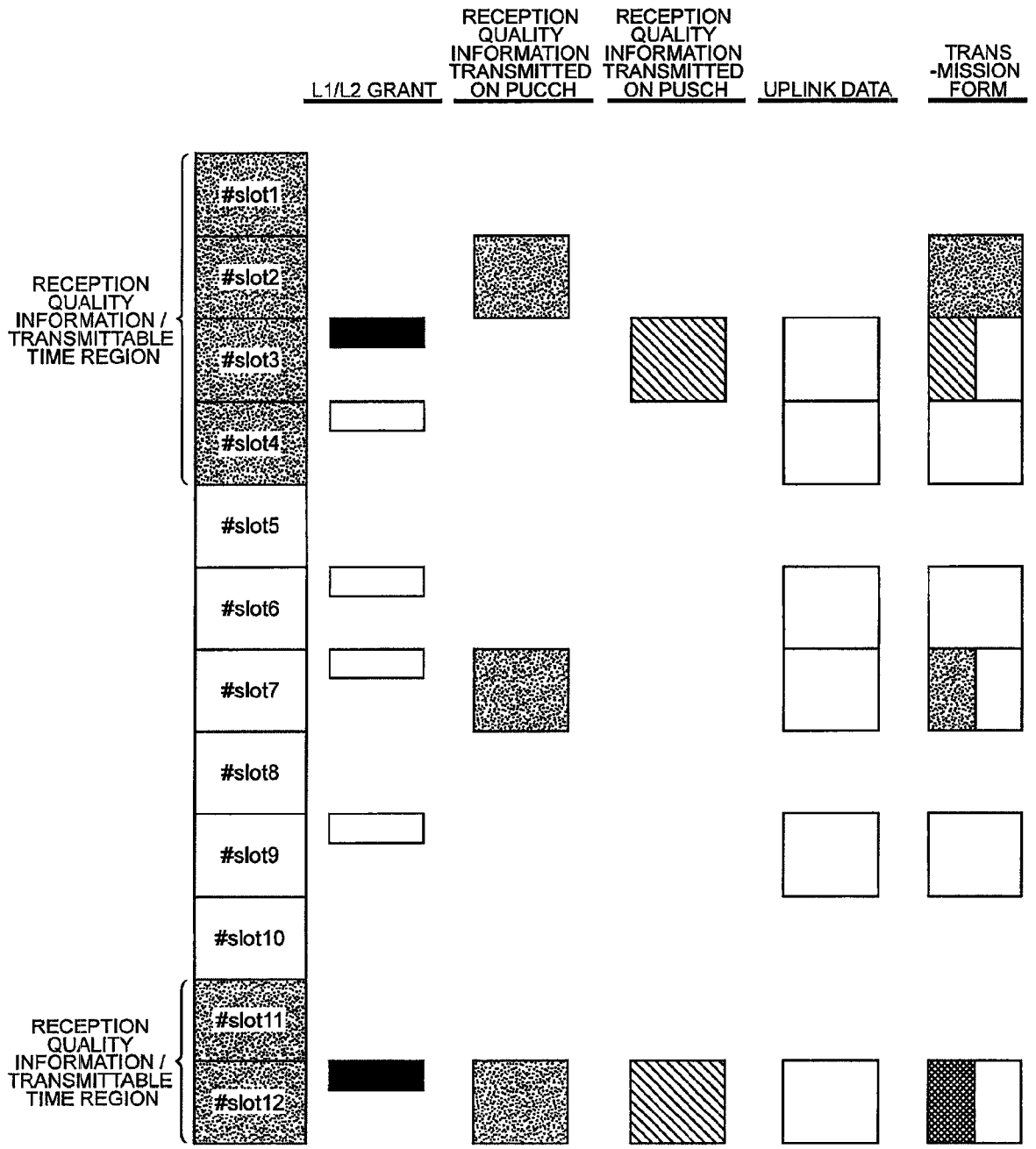

L1/L2 GRANT
RECEPTION QUALITY INFORMATION TRANSMITTED ON PUCCH
RECEPTION QUALITY INFORMATION TRANSMITTED ON PUSCH
UPLINK DATA
TRANS -MISSION FORM
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
#slot11
#slot12

FIG. 17

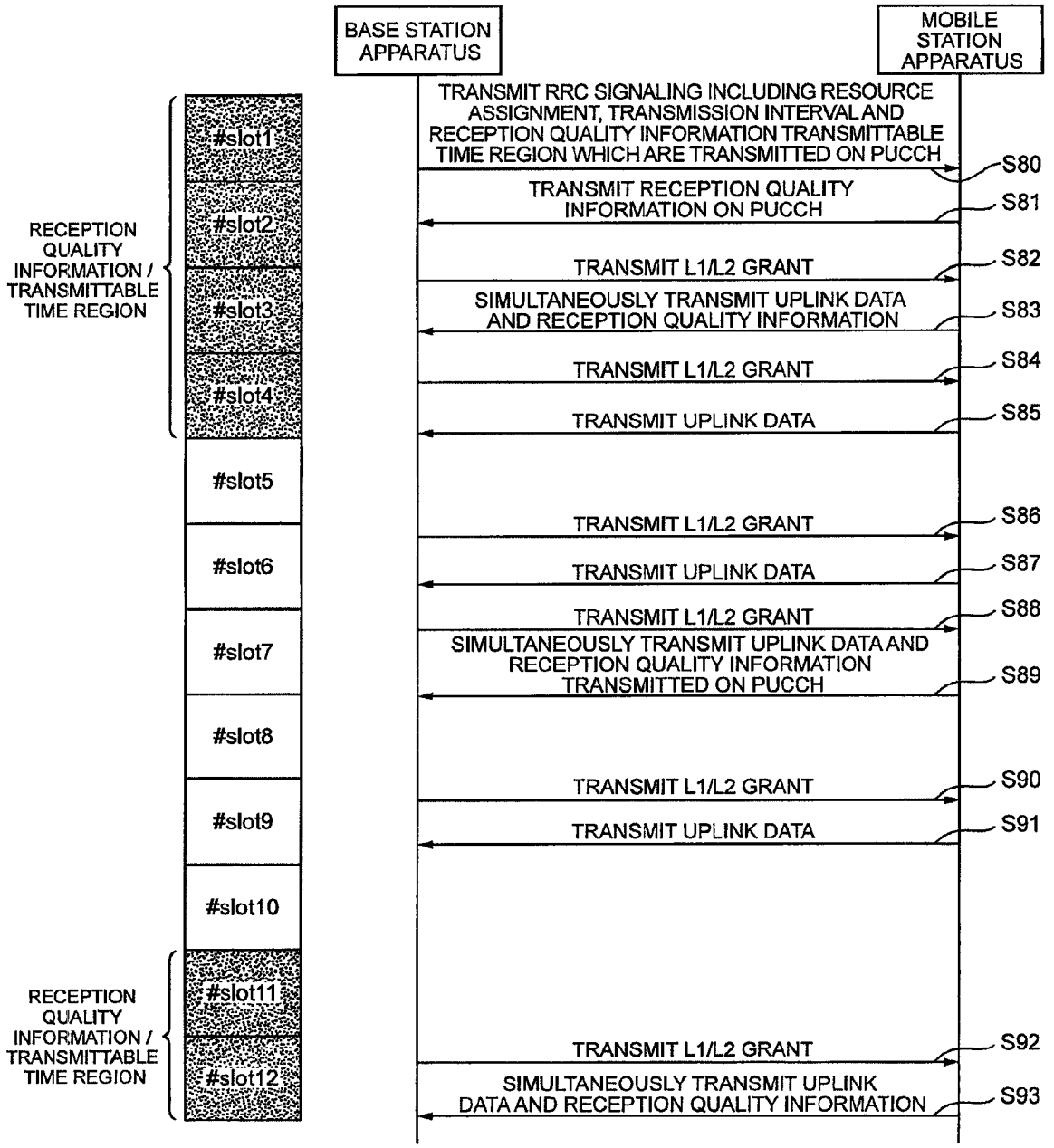
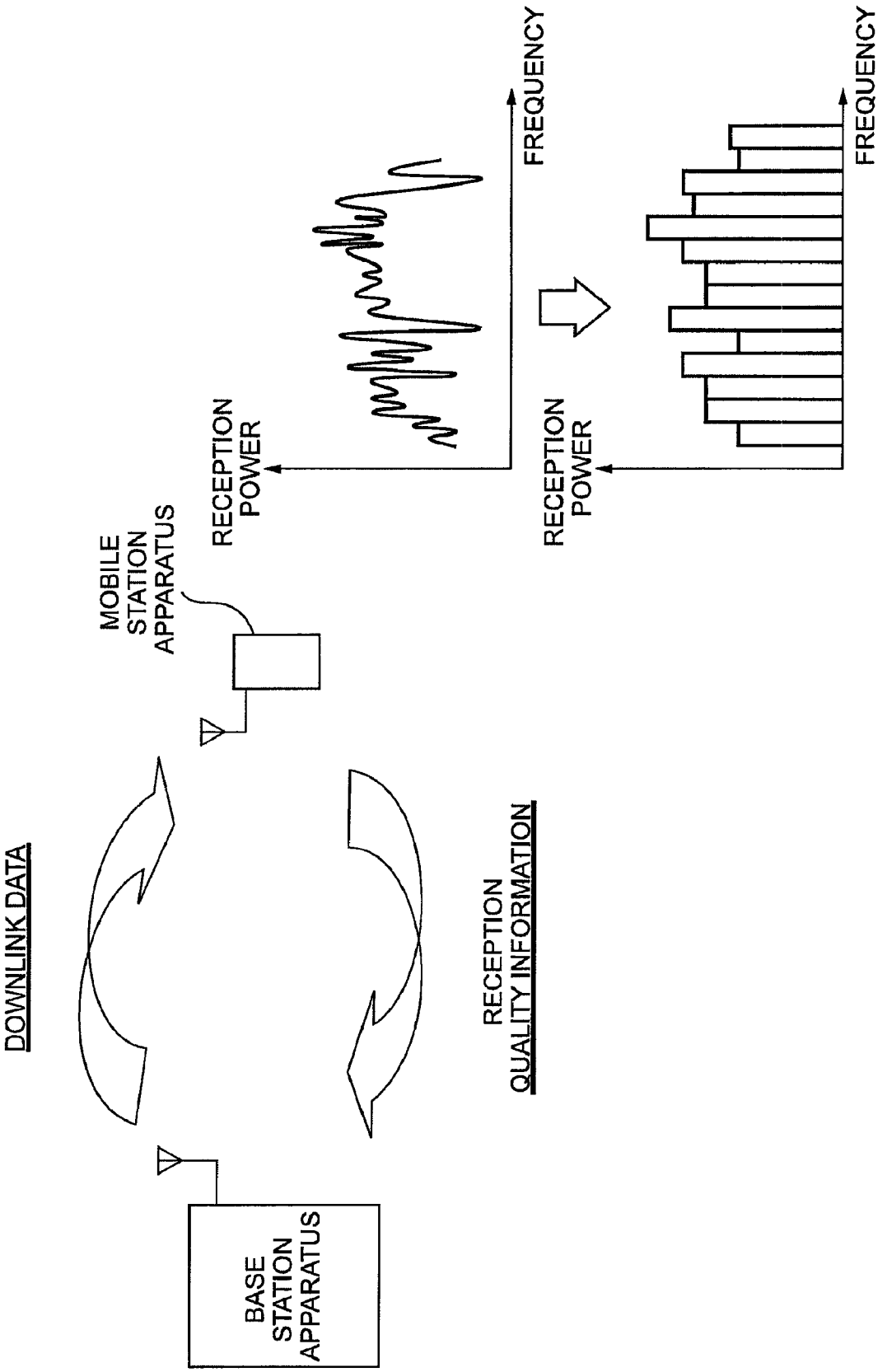

BASE STATION APPARATUS
MOBILE STATION APPARATUS
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
#slot1
#slot2
#slot3
#slot4
#slot5
#slot6
#slot7
#slot8
#slot9
#slot10
#slot11
#slot12
RECEPTION QUALITY INFORMATION / TRANSMITTABLE TIME REGION
TRANSMIT RRC SIGNALING INCLUDING RESOURCE ASSIGNMENT, TRANSMISSION INTERVAL AND RECEPTION QUALITY INFORMATION TRANSMITTABLE TIME REGION WHICH ARE TRANSMITTED ON PUCCH
S80
TRANSMIT RECEPTION QUALITY INFORMATION ON PUCCH
S81
TRANSMIT L1/L2 GRANT
S82
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S83
TRANSMIT L1/L2 GRANT
S84
TRANSMIT UPLINK DATA
S85
TRANSMIT L1/L2 GRANT
S86
TRANSMIT UPLINK DATA
S87
TRANSMIT L1/L2 GRANT
S88
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION TRANSMITTED ON PUCCH
S89
TRANSMIT L1/L2 GRANT
S90
TRANSMIT UPLINK DATA
S91
TRANSMIT L1/L2 GRANT
S92
SIMULTANEOUSLY TRANSMIT UPLINK DATA AND RECEPTION QUALITY INFORMATION
S93

FIG. 18


BASE STATION APPARATUS
MOBILE STATION APPARATUS
DOWNLINK DATA
RECEPTION QUALITY INFORMATION
RECEPTION POWER
FREQUENCY
RECEPTION POWER
FREQUENCY

MOBILE COMMUNICATION SYSTEM, BASE STATION APPARATUS, AND MOBILE STATION APPARATUS

This application is a Divisional of co-pending application Ser. No. 12/529,152 filed on Sep. 15, 2009 and for which priority is claimed under 35 U.S.C. §120, Application No. JP2007-152560 filed Jun. 8, 2007 is the national phase of PCT International Application No. PCT/2008/060453 filed on Jun. 6, 2008 under 35 U.S.C. §371. The entire contents of each of the above-identified applications are hereby incorporated by reference.

TECHNICAL FIELD

The present invention relates to a mobile station system in which a mobile station apparatus measures reception quality of a signal received from a base station apparatus to transmit reception quality information to the base station apparatuses, and relates to a base station apparatus and a mobile station apparatus which are applied to such a mobile communication system.

BACKGROUND ART

In recent years, in mobile communication systems, there is increased demand of data communication and there are proposed various technologies in which high spectrum efficiency responding to an increase of transmission data following the increased demand. As one of technologies for enhancing the spectrum efficiency, there is OFDMA (Orthogonal Frequency Division Multiple Access). This OFDMA relates to a technology of modulation method in performing communication by using the same frequency at all cells within communication area composed of cells and can realize high speed data communication.

In scheduling of transmission packets in the OFDMA system, there is known a method in which mobile station apparatuses transmit, to the base station apparatus, CQI (Channel Quality Indicator) which is information indicating reception quality of a downlink state for subcarriers in wideband, and the base station apparatus performs scheduling of the packet on the basis of the CQI of subcarriers in wideband transmitted from the each mobile station apparatuses.

Moreover, in scheduling of transmission packets in an OFDM (Orthogonal Frequency Division Multiplexing) system using plural subcarriers, there is also known a technology in which mobile station apparatuses evaluate each channel states of a downlink (frequency characteristics, i.e., characteristics of transmission loss, etc., depending on frequency) and transmit information obtained by quantizing each channel states to the base station apparatus, and the base station apparatus determines subcarriers assigned to each mobile station apparatuses on the basis of the transmitted information (Patent Literature 1).

FIG. **18** is a view for illustrating a conventional communication method between the base station apparatus and the mobile station apparatus. Having received downlink information of the downlink used for reception quality measurement from the base station apparatus, the mobile station apparatus measures the reception quality of each channel on the basis of the downlink information to create a channel profile of propagation path.

The channel profile the mobile station apparatus has created is transmitted from the mobile station apparatus to the base station apparatus as reception quality information using an uplink. The base station apparatus performs processing of

adaptive modulation and coding or frequency selective scheduling on a signal to be transmitted from the base station apparatus to the mobile station apparatus on the base of the reception quality information.

In regard to transmission of the reception quality information to the base station apparatus by the mobile station apparatus, in evolution of the third-generation radio access (Evolved Universal Terrestrial Radio Access) being studied by the 3GPP (3rd Generation Partnership Project) which is the International Standardization Project, it is studied that the reception quality information is transmitted from the mobile station apparatus to the base station apparatus using a dedicated uplink control channel (hereinafter referred to as PUCCH (Physical Uplink Control Channel), or an uplink data channel (hereinafter refereed to as PUSCH (Physical Uplink Shared Channel).

For example, in the non Patent Literature 1, there is proposed a method to transmit, in transmitting the reception quality information from the mobile station apparatus to the base station apparatus, the reception quality information using the PUCCH or the PUSCH depending on a kind of services different in required the reception quality information.

Patent Literature 1: Japanese Patent Application Laid Open No. 2005-130491

Non-Patent literature 1: "CQI handling during DRX", 3GPP, TSG RAN WG2 Meeting #58, R2-071901, May 2007

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

However, in the prior arts, there are no practical description of what kind of control information the base station apparatus use to control the mobile station apparatus in transmitting, on the PUCCH or the PUSCH, the reception quality information from the mobile station apparatus to the base station apparatus, and what kind of information exchange between the base station apparatus and the mobile station apparatus so that the reception quality information is transmitted.

In transmission of the reception quality information, for example, there are instances where the base station apparatus needs to transmit, to the mobile station apparatus, a large information amount such as the reception quality information with respect to all channels obtained by dividing a transmission frequency band every predetermined regions in order to perform suitable frequency selective scheduling.

On the other hand, for example, there are also cases where the base station apparatus requires the mobile station apparatus to transmit the reception quality information of small information amount such as average value of wideband in order to perform adaptive modulation and coding, and the size of information amount of the reception quality information to be transmitted from the mobile station apparatus to the base station apparatus has a wide range.

In addition, there is a demand such that the base station apparatus controls the size and the transmission frequency of the reception quality information. The base station apparatus should control the size and the transmission frequency of the transmitted reception quality information in consideration of an uplink resource within a cell the base station apparatus itself controls. If large-sized reception quality information is transmitted at high frequency based on the decision of each mobile station apparatus, the uplink resource within the cell runs out. On the other hand, if small-sized reception quality information is transmitted at low frequency, the uplink resource will be wastefully used.

Namely, in transmission of the reception quality information from the mobile station apparatus to the base station apparatus, it is very important to control the mobile station apparatus using what kind of control information from the base station apparatus, and to transmit the reception quality information by performing what kind of information exchange between the base station apparatus and the mobile station apparatus, and it is required to employ an efficient transmission control method in consideration of the information amount and the transmission frequency of the reception quality information to be transmitted.

The present invention is made in view of such circumstances, and its object is to provide a mobile communication system, a base station apparatus and a mobile station apparatus which can realize the efficient transmission control of the reception quality information which can flexibly treat the information amount and the transmission frequency of the reception quality information.

Means for Solving the Problems

(1) In order to attain the above mention objects, the following means were carried out in the present invention. Namely, a mobile communication system according to the present invention is directed to a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, wherein said base station apparatus transmits, to said mobile station apparatus, an uplink data transmission permission signal including a transmission instruction of reception quality information, and wherein said mobile station apparatus transmits, to said base station apparatus, reception quality information in case that a transmission instruction of said reception quality information is included in said uplink data transmission permission signal.

(2) Moreover, in the mobile communication system of the present invention, said mobile station apparatus transmits, to said base station apparatus, said reception quality information using an uplink data channel.

(3) Further, in the mobile communication system of the present invention, said mobile station apparatus transmits, to said base station apparatus, said reception quality information together with uplink data.

(4) Further, mobile communication system of the present invention is directed to a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, wherein said base station apparatus: transmits, to said mobile station apparatus, a radio resource control signal including a transmission instruction for periodically transmitting first reception quality information; and transmits, to said mobile station apparatus, an uplink data transmission permission signal including a transmission instruction of second reception quality information, and wherein said mobile station apparatus: periodically transmits, to said base station apparatus, said first reception quality information according to said radio resource control signal including a transmission instruction for periodically transmitting said first reception quality information; and transmits, to said base station apparatus, said second reception quality information in case that a transmission instruction of said reception quality information is included in said uplink data transmission permission signal.

(5) Further, the mobile communication system is directed to a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, wherein said base station apparatus: transmits, to said mobile station apparatus, a radio resource control signal including a transmission instruction for periodically transmitting first reception quality information; and transmits, to said mobile station apparatus, an uplink data transmission permission signal including a transmission instruction of second reception quality information, and wherein said mobile station apparatus: periodically transmits, to said base station apparatus, said first reception quality information according to said radio resource control signal including a transmission instruction for periodically transmitting said first reception quality information; transmits, to said base station, said second reception quality information apparatus in case that receiving said uplink data transmission permission signal including a transmission instruction of said second reception quality information; and transmits said second reception quality information in case that transmission of said first reception quality information and transmission of said second reception quality information would occur at the same time.

(6) Further, the mobile communication system of the present invention is directed to a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, wherein said base station apparatus: transmits, to said mobile station apparatus, a radio resource control signal including a transmission instruction for periodically transmitting first reception quality information; and transmits an uplink data transmission permission signal to said mobile station apparatus, and wherein said mobile station apparatus: periodically transmits said first reception quality information using an uplink control channel according to said radio resource control signal including a transmission instruction for periodically transmitting said first reception quality information to said base station apparatus; transmits said second reception quality information using an uplink data channel in case that a transmission instruction of reception quality information is included in said uplink data transmission permission signal; and transmits said first reception quality information using an uplink data channel in case that transmission of said first reception quality information and transmission using an uplink data channel according to an uplink data transmission permission signal which does not include a transmission instruction of said reception quality information would occur at the same time.

(7) Further, in the mobile communication system of the present invention, said first reception quality information transmitted using said uplink data channel has a form in which reception quality information is transmitted using an uplink control channel.

(8) The mobile communication system is directed to a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, wherein said base station apparatus transmits, to said mobile station apparatus, said uplink data transmission permission signal including a transmission instruction of reception quality information, and wherein said mobile station apparatus transmits, to said base station apparatus, reception quality information using said uplink data channel by modulating the information with a modulation scheme corresponding to a modulation scheme of uplink data specified by said uplink data transmission permission signal in case that a transmission instruction of said

reception quality information is included in said uplink data transmission permission signal.

(9) Further, the mobile communication system of the present invention is directed to a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, wherein said base station apparatus transmits, to said mobile station apparatus, said uplink data transmission permission signal including a transmission instruction of reception quality information, and wherein said mobile station apparatus transmits, to said base station apparatus, reception quality information using said uplink data channel by coding the information with a coding scheme corresponding to a coding scheme of uplink data specified by said uplink data transmission permission signal in case that a transmission instruction of said reception quality information is included in said uplink data transmission permission signal.

(10) Further, the mobile communication system of the present invention is directed to a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, wherein said base station apparatus transmits, to said mobile station apparatus, an uplink data transmission permission signal including a transmission instruction of reception quality information, and wherein said mobile station apparatus transmits, to said base station apparatus, reception quality information together with uplink data by assigning the reception quality information in a low frequency band of uplink data channel in case that a transmission instruction of said reception quality information is included in said uplink data transmission permission signal.

(11) Further, the mobile communication system of the present invention is directed to A mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, wherein said base station apparatus: transmits, to said mobile station apparatus, a radio resource control signal including information for specifying a physical format in transmitting reception quality information together with uplink data; and transmits, to said mobile station apparatus, an uplink data transmission permission signal including a transmission instruction of reception quality information, and wherein said mobile station apparatus transmits, to said base station apparatus, reception quality information together with uplink data according to information for specifying a physical format in transmitting reception quality information together with uplink data included in said radio resource control signal in case that a transmission instruction of said reception quality information is included in said uplink data transmission permission signal.

(12) Further, in the mobile communication system of the present invention, information for specifying said physical format is information for determining ratio of reception quality information transmitted together with said uplink data.

(13) Further, in the mobile communication system of the present invention, information for specifying said physical format is information for specifying a modulation scheme of reception quality information.

(14) Further, in the mobile communication system of the present invention, information for specifying said physical format is information for specifying a coding scheme of reception quality information.

(15) Further, the mobile communication system of the present invention is directed to a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, wherein said base station apparatus transmits, to said mobile station apparatus, an uplink data transmission permission signal, and wherein said mobile station apparatus: periodically transmits, to said base station apparatus, first reception quality information even in case that a transmission instruction of reception quality information is not included in said uplink data transmission permission signal; transmits, to said base station apparatus, second reception quality information in case that a transmission instruction of reception quality information is included in said uplink data transmission permission signal; and transmits said first reception quality information and second reception quality information in different physical formats.

(16) Further, in the mobile communication system of the present invention, said first reception quality information and second reception quality information have ratios with respect to uplink data which are different from each other.

(17) Further, in the mobile communication system of the present invention, said first reception quality information and second reception quality information have modulation schemes different from each other.

(18) Further, in the mobile communication system of the present invention, said first reception quality information and second reception quality information have coding schemes different from each other.

(19) Further, the mobile communication system of the present invention is directed to a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus: wherein said base station apparatus transmits, to said mobile station apparatus, an uplink data transmission permission signal; wherein said mobile station apparatus: periodically transmits, to said base station apparatus, first reception quality information even in case that a transmission instruction of reception quality information is not included in said uplink data transmission permission signal; and transmits, to said base station apparatus, second reception quality information in case that a transmission instruction of reception quality information is included in said uplink data transmission permission signal; and wherein information amount of said second reception quality information is larger than that of said first reception quality information.

(20) Further, a base station apparatus of the present invention is directed to a base station apparatus in a mobile communication system in which a mobile station apparatus transmits, to said base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said base station apparatus comprising, means for transmitting a transmission instruction of said reception quality information included in an uplink data transmission permission signal to said mobile station apparatus.

(21) Further, the base station apparatus of the present invention is directed to a base station apparatus in a mobile communication system in which a mobile station apparatus transmits, to said base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said base station apparatus comprising: means for transmitting a radio resource control signal including a transmission instruction for periodically transmitting first reception quality information to said mobile station apparatus; and means for transmitting a transmission

instruction of second reception quality information included in an uplink data transmission permission signal to said mobile station apparatus.

(22) Further, the base station apparatus of the present invention is directed to a base station apparatus in a mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, comprising: means for transmitting, to said mobile station apparatus, a radio resource control signal including information for specifying a physical format in transmitting said reception quality information together with uplink data; and means for transmitting, to said mobile station apparatus, a transmission instruction of said reception quality information included in an uplink data transmission permission signal.

(23) Further, in the base station apparatus of the present invention, information for specifying said physical format is information for determining ratio of reception quality information transmitted together with said uplink data.

(24) Further, in the base station apparatus of the present invention, information for specifying said physical format is information for specifying a modulation scheme of reception quality information.

(25) Further, in the base station apparatus of the present invention, information for specifying said physical format is information for specifying a coding scheme of reception quality information.

(26) Further, the mobile station apparatus of the present invention is directed to a mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising: means for receiving an uplink data transmission permission signal from said base station apparatus; and means for transmitting reception quality information to said base station apparatus in case that a transmission instruction of reception quality information is included in said uplink data transmission permission signal.

(27) Further, the mobile station apparatus of the present invention is directed to a mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising: means for receiving a radio resource control signal including a transmission instruction for periodically transmitting first reception quality information from said base station apparatus; means for receiving an uplink data transmission permission signal from said base station apparatus; means for periodically transmitting said first reception quality information to said base station apparatus according to said radio resource control signal including a transmission instruction for periodically transmitting first reception quality information; and means for transmitting second reception quality information to said base station apparatus in case that a transmission instruction of reception quality information is included in said uplink data transmission permission signal.

(28) Further, the mobile station apparatus of the present invention is directed to A mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising: means for receiving a radio resource control signal including a transmission instruction for periodically transmitting first reception quality information from said base station apparatus; means for receiving an uplink data transmission permission signal from said base station apparatus; means for periodically transmitting said first reception quality information to said base station apparatus according to said radio resource control signal including a transmission instruction for periodically transmitting said first reception quality information; means for transmitting said second reception quality information to said base station apparatus in case that receiving an uplink data transmission permission signal including a transmission instruction of said second reception quality information; and means for transmitting said second reception quality information to said base station apparatus in case that transmission of said first reception quality information and transmission of said second reception quality information would occur at the same time.

(29) Further, the mobile station apparatus of the present invention is directed to a mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising; means for receiving a radio resource control signal including a transmission instruction for periodically transmitting first reception quality information from said base station apparatus; means for receiving an uplink data transmission permission signal from said base station apparatus; means for periodically transmitting said first reception quality information using an uplink control channel to said base station apparatus according to said radio resource control signal including a transmission instruction for periodically transmitting said first reception quality information; means for transmitting second reception quality information using an uplink data channel to said base station apparatus in case that a transmission instruction of reception quality information is included in said uplink data transmission permission signal, and means for transmitting said first reception quality information using an uplink data channel in case that transmission of said first reception quality information and transmission using an uplink data channel according to an uplink data transmission permission signal which does not include a transmission instruction of said reception quality information would occur at the same time.

(30) Further, the mobile station apparatus of the present invention is directed to A mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising: means for receiving an uplink data transmission permission signal from said base station apparatus; means for transmitting reception quality information by modulating the information with a modulation scheme corresponding to a modulation scheme of uplink data specified by said uplink data transmission permission signal in case that a transmission instruction of said reception quality information is included in said uplink data transmission permission signal.

(31) Further, the mobile station apparatus of the present invention is directed to A mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising: means for receiving an uplink data transmission permission signal from said base station apparatus; and means for transmitting reception quality information by coding the information with a coding scheme corresponding to a coding

scheme of uplink data specified by said uplink data transmission permission signal in case that a transmission instruction of said reception quality information is included in said uplink data transmission permission signal.

(32) Further, the mobile station apparatus of the present invention is directed to A mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising: means for receives an uplink data transmission permission signal from said base station apparatus; and means for transmits reception quality information together with uplink data using said uplink data channel by arranging the information in a low frequency band of uplink data channel assigned by said uplink data transmission permission signal in case that a transmission instruction of said reception quality information is included in said uplink data transmission permission signal.

(33) Further, the mobile station apparatus of the present invention is directed to A mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising: means for receiving, from said base station apparatus, a radio resource control signal including information for specifying a physical format in transmitting reception quality information together with uplink data; and means for transmitting, to said base station apparatus, reception quality information together with uplink data according to information for specifying a physical format in transmitting said reception quality information together with uplink data included in said radio resource control signal

(34) Further, in the mobile station apparatus of the present invention, information for specifying said physical format is information for determining ratio of reception quality information transmitted together with said uplink data.

(35) Further, in the mobile station apparatus of the present invention, information for specifying said physical format is information for specifying a modulation scheme of reception quality information.

(36) Further, in the mobile station apparatus of the present invention, information for specifying a physical format is information for specifying a coding scheme of reception quality information.

(37) Further, the mobile station apparatus of the present invention is directed to A mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising: means for receiving an uplink data transmission permission signal from said base station apparatus; means for periodically transmitting first reception quality information to said base station apparatus even in case that a transmission instruction of reception quality information is not included in said uplink data transmission permission signal; and means for transmitting second reception quality information to said base station apparatus in case that a transmission instruction of reception quality information is included in said uplink data transmission permission signal, wherein said first reception quality information and said second reception quality information are transmitted in different physical formats.

(38) Further, in the mobile station apparatus of the present invention, said first reception quality information and said second reception quality information have ratios with respect to uplink data different from each other.

(39) Further, in the mobile station apparatus of the present invention, said first reception quality information and said second reception quality information are modulated by different modulation schemes.

(40) Further, in the mobile station apparatus of the present invention, said first reception quality information and said second reception quality information are coded by different coding schemes.

(41) Further, the mobile station apparatus of the present invention is directed to A mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, reception quality information indicating quality of a signal received from said base station apparatus, said mobile station apparatus comprising: means for receiving an uplink data transmission permission signal from said base station apparatus; means for periodically transmitting first reception quality information to said base station apparatus even in case that a transmission instruction of reception quality information is not included in said uplink data transmission permission signal; and means for transmitting second reception quality information to said base station apparatus in case that a transmission instruction of reception quality information is included in said uplink data transmission permission signal, wherein information amount of said second reception quality information is larger than that of first reception quality information.

Advantage Effect of the Invention

According to the present invention, the base station apparatus can control the transmission frequency of the reception quality information. In addition, it is possible to perform the transmission control of the reception quality information in consideration of the uplink resource within a cell.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram showing a schematic configuration of a base station apparatus according to a first embodiment of the present invention.

FIG. **2** is a block diagram showing a schematic configuration of a mobile station apparatus according to the first embodiment of the present invention.

FIG. **3** is a view showing a control signal transmitted from the base station apparatus to the mobile station apparatus, and the reception quality information, the uplink data which are transmitted from the mobile station apparatus to the base station apparatus, and the reception quality information transmission form in the first embodiment according to the present invention.

FIG. **4** is a view showing transmission form when the mobile station apparatus simultaneously transmits the uplink data and the reception quality information.

FIG. **5** is a view showing content and form transmitted in the slot in the first embodiment according the present invention.

FIG. **6** is a sequence chart showing the operation of the first embodiment according to the present invention.

FIG. **7** is a view showing content and form transmitted in the slot when a physical format for simultaneous transmission is specified by RRC signaling from the base station apparatus to the mobile station apparatus in the first embodiment of the present invention.

FIG. **8** is a sequence chart of operation when a physical format for simultaneous transmission is specified by RRC

signaling from the base station apparatus to the mobile station apparatus in the first embodiment of the present invention.

FIG. **9** is a view showing a control signal transmitted from the base station apparatus to the mobile station apparatus, and the reception quality information, the uplink data which are transmitted from the mobile station apparatus to the base station apparatus, and the reception quality information transmission form in a second embodiment according to the present invention.

FIG. **10** is a view showing content and form transmitted in the slot in the second embodiment according to the present invention.

FIG. **11** is a sequence chart showing the operation of the second embodiment according to the present invention.

FIG. **12** is a view showing a control signal transmitted from the base station apparatus to the mobile station apparatus, and the reception quality information, the uplink data which are transmitted from the mobile station apparatus to the base station apparatus, and the reception quality information transmission form in a third embodiment according to the present invention.

FIG. **13** is a view showing content and form transmitted in the slot in the third embodiment according to the present invention.

FIG. **14** is a sequence chart showing the operation of the third embodiment according to the present invention.

FIG. **15** is a view showing a control signal transmitted from the base station apparatus to the mobile station apparatus, and the reception quality information, the uplink data which are transmitted from the mobile station apparatus to the base station apparatus, and the reception quality information transmission form in a fourth embodiment according to the present invention.

FIG. **16** is a view showing content and form transmitted in the slot in the fourth embodiment according to the present invention.

FIG. **17** is a sequence chart showing the operation of the fourth embodiment according to the present invention.

FIG. **18** is a view for explaining a communication method between the base station apparatus and the mobile station apparatus.

DESCRIPTION OF REFERENCE NUMERALS

100 base station apparatus
101 data control unit
102 modulation encoding unit
103 mapping unit
104 IFFT unit
105 radio transmission unit
106 radio reception unit
107 FFT unit
108 demodulation decoding unit
109 data extracting unit
110 scheduler unit
111 transmission information control unit
111*a* modulation and coding control unit
111*b* frequency selective scheduler unit
112 antenna
200 mobile station apparatus
201 data control unit
202 modulation encoding unit
203 mapping unit
204 IFFT unit
205 radio transmission unit
206 radio reception unit
207 FFT unit
208 demodulation decoding unit
209 data extracting unit
210 reception quality information control unit
210*a* reception quality information generating unit
210*b* reception quality measurement unit
211 antenna

BEST MODE FOR CARRYING OUT THE INVENTION

First Embodiment

First of all, a mobile communication system according to a first embodiment of the present invention will be described. This mobile communication system is composed of a base station apparatus and mobile station apparatuses. FIG. **1** is a block diagram showing a schematic configuration of the base station apparatus according to the first embodiment of the present invention. A base station apparatus **100** comprises a data control unit **101**, a modulation encoding unit **102**, a mapping unit **103**, an Inverse Fast Fourier Transform (IFFT) unit **104**, a radio transmission unit **105**, radio reception unit **106**, a Fast Fourier Transform (FFT) unit **107**, a demodulation decoding unit **108**, a data extracting unit **109**, a scheduler unit **110**, a transmission information control unit **111** and an antenna **112**. The transmission information control unit **111** includes a modulation and coding control unit **111***a*, and a frequency selective scheduler unit **111***b*.

In the base station apparatus **100**, the data control unit **101** receives transmission data and control data which are transmitted to the each mobile station apparatuses and sequentially transmits respective data to the mobile station apparatuses according to instruction from the scheduler unit **110**. The modulation encoding unit **102** performs modulation processing and error correction coding processing on a signal output from the data control unit **101** on the basis of modulation scheme and coding rate determined by the modulation code control unit **111***a* to output the respective data to the mapping unit **103**. The mapping unit **103** performs mapping of data output from the modulation encoding unit **102** onto respective subcarriers on the basis of frequency selective scheduling information output from the frequency selective scheduler unit **111***b* to output the mapped data to the Inverse Fast Fourier Transform unit **104**.

The Inverse Fast Fourier Transform unit **104** performs processing of Inverse Fast Fourier Transform on data output from the mapping unit **103**, converts the data thus processed into a base band digital signal of time series to output the digital signal thus provided, and outputs the converted data to the radio transmission unit **105**. A signal output from the Inverse Fast Fourier Transform unit **104** is subjected to digital analog conversion at the radio transmission unit **105**, up-converted into a signal having frequency suitable for transmission, and then transmitted to the respective mobile station apparatuses through the antenna **112**.

The scheduler unit **110** performs scheduling of downlink and scheduling of uplink on the basis of control information that each mobile station apparatuses can use, such as resource region, intermittent transmitting/receiving cycle, transmission data channel format and buffer state. The modulation and coding control unit **111***a* determines modulation scheme and coding rate to be applied to respective data on the basis of reception quality information transmitted from the mobile station apparatus to output them to the modulation encoding unit **102**. The frequency selective scheduler unit **111***b* performs processing of frequency selective scheduling to be applied to respective data on the basis of reception quality

information transmitted from the mobile station apparatus to output the result to the mapping unit **103**.

FIG. **2** is a block diagram showing a schematic configuration of the mobile station apparatus of the first embodiment of present invention. A mobile station apparatus **200** comprises, a data control unit **201**, a modulation encoding unit **202**, a mapping unit **203**, an Inverse Fast Fourier Transform (IFFT) unit **204**, a radio transmission unit **205**, a radio reception unit **206**, a Fast Fourier Transform (FFT) unit **207**, a demodulation decoding unit **208**, a data extracting unit **209**, a reception quality information control unit **210**, and an antenna **211**. The reception quality information control unit **210** includes a reception quality information generating unit **210***a*, and a reception quality measurement unit **210***b*.

In the mobile station apparatus **200**, the data control unit **201** receives transmission data and control data to be transmitted to the base station apparatus, and sequentially transmits respective data to the base station apparatus. The modulation encoding unit **202** performs modulation processing and error correction coding processing on a signal output from the data control unit **201** to output respective data to the mapping unit **203**. The mapping unit **203** performs mapping of data output from the modulation encoding unit **202** onto the respective sub carriers to output the mapped data to the Inverse Fast Fourier Transform unit **204**.

The Inverse Fast Fourier Transform unit **204** performs processing of Inverse Fast Fourier Transform on a symbol sequence output from the mapping unit **203** to convert it in to a time-series base band digital signal, and outputs thus converted signal to the radio transmission unit **205**. The output signal from the Inverse Fast Fourier Transform unit **204** is subjected to digital analog conversion at the radio transmission unit **205** and up-converted into a signal having a frequency suitable for transmission. Thereafter, the signal thus obtained is transmitted to the base station apparatus through the antenna **211**.

The reception quality measurement unit **210***b* measures reception quality of a signal received from the base station apparatus. The reception quality information generating unit **210***a* generates reception quality information transmitted to the base station apparatus on the basis of information measured by the reception quality measurement unit **210***b*.

FIG. **3** is a view showing a control signal transmitted from the base station apparatus to the mobile station apparatus, and the reception quality information, the uplink data which are transmitted from the mobile station apparatus to the base station apparatus, and the reception quality information transmission form. FIG. **3** shows, as an example, the operation from #slot**1** to #slot**24**. The mobile station apparatus transmits data using PUSCH according to resource assignment indicated by a downlink control channel (referred to as PDCCH (Physical Downlink Control Channel)) from the base station apparatus. Namely, this downlink control channel PDCCH is a signal for permitting data transmission in the uplink (hereinafter referred to as "L1/L2 grant" meaning uplink data transmission permission signal).

The operation of the base station apparatus and the mobile station apparatus at #slot**2** in FIG. **3** will be described. The base station apparatus which has determined to instruct the mobile station apparatus to transmit the reception quality information transmits the L1/L2 grant (uplink data transmission permission signal) which includes simultaneous transmission permission information for giving an instruction to simultaneously transmit the uplink data and the reception quality information. The mobile station apparatus having received the L1/L2 grant including the simultaneous transmission permission information simultaneously transmits, to the base station apparatus, the uplink data and the reception quality information as indicated by slanting line attached rectangular shape of FIG. **3**. It is shown that at #slot**2**, from the base station apparatus, the L1/L2 grant including the simultaneous transmission permission information is transmitted using the PDCCH at a timing for controlling #slot**2** to the mobile station apparatus, and the mobile station apparatus having received the signal simultaneously transmits, to the base station apparatus, the uplink data and the reception quality information.

Further, at #slot**3**, from the base station apparatus, the L1/L2 grant which does not include the simultaneous transmission permission information is transmitted to the mobile station apparatus, and the mobile station apparatus having received the signal transmits, to the base station apparatus, the uplink data using the PUSCH in a physical format which does not include the reception quality information, as indicated by a white rectangle. FIG. **3** similarly shows that the L1/L2 grant which includes the simultaneous transmission permission information is transmitted from the base station apparatus at #slot**9** and #slot**20**, and the mobile station apparatus having received the signal simultaneously transmits the uplink data and the reception quality information.

FIG. **4** is a view showing transmission form when the mobile station apparatus simultaneously transmits the uplink data and the reception quality information. FIG. **4** shows, as an example, two physical formats (transmission form **1** and transmission form **2**). Data transmitted from the mobile station apparatus to the base station apparatus is represented by 14 OFDM symbols, and there are arranged, in these 14 OFDM symbols, known reference symbols (pilot signal which will be refereed to as RS hereinafter) used for propagation path estimation for performing data demodulation and the reception quality information and the uplink data having the numbers different from each other in the transmission forms **1** and the transmission form **2**.

In the transmission form **1**, there are arranged the reception quality information at the 2nd, 6-th, 9-th, and 13-th OFDM symbols and the uplink data at 3-rd, 4-th, 7-th, 10-th, 11-th and 14-th OFDM symbols. In the transmission form **2**, there are arranged the reception quality information at 2nd, 4-th, 6-th, 9-th, 11-th and 13-th OFDM symbols and the uplink data at 3-rd, 7-th, 10-th and 14-th OFDM symbols.

The L1/L2 grant including the simultaneous transmission permission information is transmitted from the base station apparatus. The mobile station apparatus having received the signal simultaneously transmits, to the base station apparatus, the uplink data and the reception quality information in transmission form as indicated by the transmission form **1** or the transmission form **2**.

The base station apparatus can specify by a RRC signaling (radio resource control signal) the physical format of the uplink data and the reception quality information the mobile station apparatus simultaneously transmits. For example, the base station apparatus sets ratio of the uplink data and the reception quality information for each OFDM symbol unit, and makes a setting in detail of the transmission form **1** or the transmission form **2** etc. For example, for transmission data of 14 OFDM symbols, there may be employed an approach to transmit information that the reception quality information is included in 4 OFDM symbols, or information that the uplink data is included in 6 OFDM symbols. Further, there may be employed an approach to simply notify transmission form selected from transmission forms determined in advance. In addition, there may be employed an approach to specify, in advance by the RRC signaling, a modulation scheme and a coding scheme for coding the reception quality information.

Further, arrangement of the RS, the uplink data and the reception quality information is changed in the time axis direction (14 OFDM) between the transmission forms **1** and the transmission forms **2** in FIG. **4**, but such arrangement may be changed with respect to the frequency axis direction. In addition such arrangement may be automatically changed depending on the size of resource of PUSCH assigned by the L1/L2 grant. For example, only the resource unit (minimum unit of time frequency block of PUSCH) arranged in a low frequency band can transmit the reception quality information, and the resource unit arranged in the remaining high frequency band can transmit only the uplink data. Also a modulation scheme and a coding scheme for coding the reception quality information may be changed according to a modulation scheme and a coding scheme of PUSCH specified by the L1/L2 grant.

The mobile station apparatus stores the physical format specified by the RRC signaling from the base station apparatus. In case that the L1/L2 grant including the simultaneous transmission permission signal is transmitted from the base station apparatus, the mobile station apparatus simultaneously transmits the uplink data and the reception quality information in the physical format (e.g., format such that 4 OFDM symbols are used for the reception quality information and 6 OFDM symbols are used for the uplink data as indicated by the transmission form **1** in FIG. **4**).

Here, there may be employed as information included in the RRC signaling with respect to the physical format for simultaneous transmission, any information such that the mobile station apparatus determines the ratio in simultaneously transmitting the uplink data and the reception quality information, such as, for example index given to plural kinds of physical format determined in advance, the number of OFDM symbols in which the uplink data is included (e.g., 6 OFDM for the uplink data in 14 OFDM), or the number of OFDM symbols in which the reception quality information is included (e.g., 4 OFDM for the reception quality information in 14 OFDM) etc.

Further, while two kinds of forms as shown in FIG. **4** as described as an example of transmission form, there may be employed any arrangement other than the above as arrangement of the RS, the uplink data and the reception quality information. In addition, there may be included information, e.g., ACK/NACK signal other than the RS, the uplink data and the reception quality information within OFDM signal to be transmitted.

FIG. **5** is a view showing content and form to be transmitted in the slot in the first embodiment according to the present invention. FIG. **6** is a sequence chart showing the operation of the first embodiment according to the present invention. In this example, for clarifying, there are shown slots and the sequence corresponding to #slot**1** to #slot**12** in FIG. **3**. In addition, the uplink may be referred to as "uplink" and the downlink may be referred to as "downlink" hereinafter.

In FIG. **5** and FIG. **6**, at #slot**2**, the base station apparatus transmits, to the mobile station apparatus, the L1/L2 grant including the simultaneous transmission permission information (step S**1**). The mobile station apparatus having received the signal simultaneously transmits, to the base station apparatus, the uplink data and the reception quality information (step S**2**). Also at #slot**9**, similar processing is performed (step S**7**, S**8**). At #slot**3**, the base station apparatus transmits, to the mobile station apparatus, the L1/L2 grant which does not include the simultaneous transmission permission information (step S**3**). The mobile station apparatus having received the signal transmits the uplink data in the physical format which does not include the reception quality information (step S**4**). Also at #slot**4**, #slot**11**, and #slot**12**, similar processing is performed (steps S**5**, S**6**, S**9**, S**10**, S**11** and S**12**).

FIG. **7** is a view showing content and form to be transmitted in the slot when the physical format for simultaneous transmission is specified by the RRC signaling from the base station apparatus to the mobile station apparatus in the first embodiment of the present invention. Moreover, FIG. **8** is a sequence chart showing the operation when the physical format for simultaneous transmission is specified by the RRC signaling from the base station apparatus to the mobile station apparatus in the first embodiment of the present invention. The embodiment shown in FIG. **7** and FIG. **8** differs from the case shown in FIGS. **5** and **6** in that the RRC signaling for specifying the physical format for simultaneous transmission is transmitted from the base station apparatus to the mobile station apparatus at #slot**1** and #slot**8**.

In FIG. **7** and FIG. **8**, at #slot**1**, the base station apparatus transmits, to the mobile station apparatus, the RRC signaling for specifying the physical format for simultaneous transmission (step S**21**). In this example, it is assumed that the transmission form **1** in FIG. **4** is specified by the RRC signaling. The mobile station apparatus stores the physical format for simultaneous transmission (the transmission form **1**). At #slot**2**, the base station apparatus transmits, to the mobile station apparatus, the L1/L2 grant including the simultaneous transmission permission signal (step S**22**). The mobile station apparatus having received the signal transmits, to the base station apparatus, the uplink data and the reception quality information in the stored transmission form **1** (step S**23**).

Next, the base station apparatus transmits, to the mobile station apparatus, the L1/L2 grant which does not include the simultaneous transmission permission signal at #slot**3** (step **24**). The mobile station apparatus transmits, to the base station apparatus, the uplink data (step S**25**). Also at #slot**4**, #slot**6**, #slot**11** and #slot**12**, similar processing is performed (step S**26**, S**27**, S**28**, S**29** and S**33** to S**36**).

At #slot**8**, the base station apparatus transmits, to the mobile station apparatus, the RRC signaling including specification of the physical format for simultaneous transmission (step S**30**). Here, it is assumed that the transform form **2** in FIG. **4** is specified by the RRC signaling. The mobile station apparatus stores the physical format for simultaneous transmission (the transmission form **2**). At #slot**9**, the base station apparatus transmits, to the mobile station apparatus, the L1/L2 grant including the simultaneous transmission permission signal (step S**31**). The mobile station apparatus having received the signal transmits, to the base station apparatus, the uplink data and the reception quality information in the stored transmission form **2** (step S**32**).

As described above, according to the first embodiment of the present invention, the base station apparatus transmits the L1/L2 grant including the simultaneous transmission permission information for permitting simultaneous transmission of the uplink data and the reception quality information, the mobile station apparatus having received the signal simultaneously transmits the uplink data and the reception quality information, and whereby the base station apparatus can control the transmission frequency of the reception quality information, thus making it possible to perform the transmission control of the reception quality information in consideration of the uplink resource within the cell.

Moreover, since the uplink data and the reception quality information can be simultaneously transmitted, it is possible to reduce wasteful use of the resource of the L1/L2 grant. Namely, when a transmission instruction of the reception quality information is given at a fixed timing using the radio resource control signal (RRC signaling) from the base station

apparatus to the mobile station apparatus, if there is a need to give a transmission instruction of the reception quality information dynamically using the uplink data transmission permission signal, it is required to give an instruction at which timing the reception quality information is to be transmitted, using the uplink data transmission permission signal from the base station apparatus to the mobile station apparatus. According to the present invention, since the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data is transmitted to the mobile station apparatus, wasteful use of the resource of the uplink data transmission permission signal is reduced in the downlink, and thereby the resource can be effectively utilized.

Further, the base station apparatus transmits the RRC signaling for specifying the physical format for simultaneous transmission in simultaneous transmitting the uplink data and the reception quality information, and thereby the transmission control to flexibly treat the information amount of the reception quality information transmitted from the mobile station apparatus can be performed.

Second Embodiment

FIG. **9** is a view showing a control signal transmitted from the base station apparatus to the mobile station apparatus, and the reception quality information, the uplink data which are transmitted from the mobile station apparatus to the base station apparatus, and the reception quality information transmission form in the second embodiment according to the present invention. FIG. **9** shows, as an example, the operation from #slot**1** to #slot**24**.

First, the base station apparatus transmits the RRC signaling which includes resource assignment and transmission interval when the mobile station apparatus transmits the reception quality information using the PUCCH. In general, since the resource region assigned as the PUCCH is smaller than the resource region assigned as the PUSCH, the size of information amount to be transmitted becomes small. Namely, the reception quality information the mobile station apparatus transmits using the PUCCH is the reception quality information having small information amount, and the reception quality information the mobile station apparatus transmits using the PUSCH is the reception quality information having large information amount.

The operation at #slot**2** will now be described. The mobile station apparatus in which the resource assignment and the transmission interval in transmitting the reception quality information using the PUCCH are set by the RRC signaling from the base station apparatus, transmits, to the base station apparatus, the reception quality information of small information amount in the set resource of the PUCCH and at the set transmission interval. FIG. **9** shows, the mobile station apparatus transmits the reception quality information using the PUCCH at the transmission interval of five slots.

Next, the operation at #slot**3** will be described. At the #slot**3**, as described in the first embodiment, the base station apparatus transmits, to the mobile station apparatus, the L1/L2 grant including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the uplink data and the reception quality information. The mobile station apparatus having received the L1/L2 grant including the simultaneous transmission permission information from the base station apparatus simultaneously transmits the uplink data and the reception quality information of large information amount using the PUSCH. The transmission form of data transmitted at this time may be controlled by the RRC signaling including the physical format for simultaneous transmission from the base station apparatus similarly to that shown in the first embodiment.

The operation of #slot**7** will now be described. The #slot**7** indicates the case where at a slot in which is set so as to transmit the reception quality information using the PUCCH in advance, further the base station apparatus transmits the L1/L2 grant including the simultaneous transmission permission information. At #slot**7**, the mobile station apparatus having received the L1/L2 grant including the simultaneous transmission permission information from the base station apparatus simultaneously transmits, to the base station apparatus, the uplink data and the reception quality information using the PUSCH.

Here, as the reception quality information transmitted simultaneously with the uplink data, there can be transmitted the reception quality information of large information amount, or the reception quality information of small information amount attempting to be transmitted on PUCCH and the reception quality information of large information amount, or the reception quality information of small information amount attempting to be transmitted on PUCCH and the relationship thereof. The reception quality information having small information amount and the relationship thereof indicates the reception quality information having small information amount attempting to be transmitted on PUCCH and difference information with respect to the reception quality information, etc. Specifically, it indicates that with the average value of wideband reception quality information as the reception quality information of small information amount, narrow band reception quality information is expressed as the difference information from the average value thereof and is transmitted. For example, in case that there is a desire to transmit four values of 15, 12, 10 and 8 as the reception quality information, the average value as small information amount is determined to be "9". Moreover, the difference information from the average value as "the relationship thereof" is determined to be 6, 3, 1 and −1. This information is transmitted simultaneously with the uplink data on PUSCH. As stated above, since the difference information of the average value can be expressed by lesser number of bits, it is possible to reduce the number of bits of the reception quality information transmitted on the uplink data channel.

Further, the operation of the base station apparatus at #slot**7** will be described. When the mobile station apparatus transmits, to the base station apparatus, the reception quality information of small information amount attempting to be transmitted on PUCCH and the reception quality information of large information amount, or the reception quality information of information amount attempting to be transmitted on PUCCH and the relationship thereof, the resource of the PUCCH which has been set by the RRC signaling in advance does not transmit any information.

The base station apparatus transmits the L1/L2 grant including the simultaneous transmission permission information to thereby recognize in advance that there is no information to be transmitted in the resource of the PUCCH. For this reason, other mobile station apparatus are performed scheduling using the resource so as to transmit information of the uplink (e.g., ACK/NACK signal).

By performing such scheduling, it is possible to use, with respect to other mobile station apparatus, the resource of the PUCCH which has been maintained in advance for transmit-

ting the reception quality information, thus making it possible to more efficiently use the uplink resource.

At #slot**12**, there is shown the case where at a slot which the base station apparatus set by the RRC signaling for the mobile station apparatus so as to transmit the reception quality information having small information amount using the PUCCH, the base station apparatus transmits the L1/L2 grant which does not include the simultaneous transmission permission information. The operation at the #slot**12** will be described. At the #slot**12**, the mobile station apparatus having received the L1/L2 grant which does not include the simultaneous transmission permission information from the base station apparatus simultaneously transmits, using the PUSCH, the uplink data and the reception quality information of small information attempting to be transmitted on the PUCCH.

At this time, as the physical format for simultaneously transmitting the uplink data and the reception quality information of small information attempting to be transmitted on the PUCCH to be transmitted using the PUSCH, a format determined in advance is used, or such format is controlled by the RRC signaling. Namely, there are defined the physical format for simultaneously transmitting the reception quality information of small information attempting to be transmitted on PUCCH and the uplink data, and the physical format for simultaneously transmitting the reception quality information of large information and the uplink data in case that receiving the L1/L2 grant including the simultaneous transmission permission information.

Also at #slot**12**, the base station apparatus transmits the L1/L2 grant which does not include the simultaneous transmission permission information to thereby in advance recognized that there is no information to be transmitted in the resource of the PUCCH, other mobile station apparatus are performed scheduling so as to transmit the uplink information, (e.g., ACK/NACK signal) using the resource.

FIG. **10** is a view showing content and form to be transmitted in the slot in the second embodiment according to the present invention. Moreover, FIG. **11** is a sequence chart showing the operation of the second embodiment according to the present invention. Here, for facilitation of explanation, there are shown slots and the sequence corresponding to #slot**1** to #slot**12** in FIG. **9**. In FIG. **10** and FIG. **11**, at #slot**1**, the resource assignment and the transmission interval when the mobile station apparatus transmits the reception quality information using the PUCCH are set by the RRC signaling from the base station apparatus. At #slot**2**, the mobile station apparatus transmits the reception quality information of small information amount in the set recourse of the PUCCH and at the set transmission interval (step S**41**). At #slot**3**, the base station apparatus transmits the L1/L2 grant including the simultaneous transmission permission information (step S**42**). The mobile station apparatus having received the signal simultaneously transmits, using the PUSCH, the uplink data and the reception quality information of large information amount (step S**43**).

At #slot**4**, the base station apparatus transmits the L1/L2 grant which does not include the simultaneous transmission permission information (step S**44**). The mobile station apparatus having received the signal transmits, using the PUSCH, the uplink data (step S**45**). Also at #slots **8** and **10**, similar processing is performed (steps S**48** to S**51**).

At #slot**7**, the base station apparatus transmits the L1/L2 grant including the simultaneous transmission permission information (step S**46**). The mobile station apparatus having received the signal transmits, using the PUSCH, the uplink data and the reception quality information of large information amount, or the uplink data and the reception quality information of small information amount attempting to be transmitted on PUCCH and the reception quality information of large information amount, or the uplink data and the reception quality information of small information amount attempting to be transmitted on PUCCH and the relationship thereof (step S**47**). In addition, the base station apparatus performs scheduling so that other mobile station apparatus can transmit the uplink information using such resource.

At #slot**12**, the base station apparatus transmits the L1/L2 grant which does not include the simultaneous transmission permission information (step S**52**). The mobile station apparatus having received the signal transmits, using the PUSCH, the uplink data and the reception quality information attempting to be transmitted on PUCCH (step S**53**). In addition, the base station apparatus performs scheduling so that other mobile station apparatus can transmit the uplink information using such resource.

As stated above, according to the second embodiment of the present invention, the base station apparatus transmits the RRC signaling including the resource and the transmission interval for transmitting the reception quality information using the PUCCH, and transmits the L1/L2 grant including the simultaneous transmission permission information for permitting simultaneous transmission of the uplink data and the reception quality information, thereby enabling control of the transmission frequency of the reception quality information and the transmission control to flexibly treat the information amount of the reception quality information.

Moreover, since the uplink data and the reception quality information can be simultaneously transmitted, it is possible to reduce wasteful use of the resource of the L1/L2 grant. Namely, when a transmission instruction of the reception quality information is given at a fixed timing using the radio resource control signal (RRC signaling) from the base station apparatus to the mobile station apparatus, if there is a need to give a transmission instruction of the reception quality information dynamically using the uplink data transmission permission signal, it is required to give an instruction at which timing the reception quality information is to be transmitted, using the uplink data transmission permission signal from the base station apparatus to the mobile station apparatus. According to the present invention, since the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data is transmitted to the mobile station apparatus, wasteful use of the resource of the uplink data transmission permission signal is reduced in the downlink, and thereby the resource can be effectively utilized.

Third Embodiment

FIG. **12** is a view showing a control signal transmitted from the base station apparatus to the mobile station apparatus, and the reception quality information, the uplink data which are transmitted from the mobile station apparatus to the base station apparatus, and the reception quality information transmission form. FIG. **12** shows, as an example, the operation from #slot**1** to #slot**24**. First, the base station apparatus transmits, to the mobile station apparatus, the RRC signaling including a reception quality information transmittable time region. This reception quality information transmittable time region is a region where the mobile station apparatus having received the L1/L2 grant at any slot within the region can simultaneously transmit the uplink data and the reception quality information. Thus, there is no necessity to include

simultaneous transmission permission information in the L1/L2 grant to be transmitted from the base station apparatus, thus making it possible to more efficiently use downlink resource.

FIG. **12** shows that the reception quality information transmittable time regions are set with respect to slots of #slot**1** to #slot**4**, #slot**11** to #slot**14** and #slot**21** to #slot**24** by the RRC signaling from the base station apparatus. Moreover, it shows that the mobile station apparatus simultaneously transmits the uplink data and the reception quality information with respect to the L1/L2 grant (#slot**2**, #slot**11** and #slot**23**) first received within the reception quality information transmittable time region.

The transmission form when the mobile station apparatus simultaneously transmits the uplink data and the reception quality information is similar to that shown in the first embodiment, and the RRC signaling including the physical format for simultaneous transmission may be transmitted from the base station apparatus.

FIG. **13** is a view showing content and form to be transmitted in the slot in the third embodiment according to the present invention. Moreover, FIG. **14** is a sequence chart showing the operation of the third embodiment according to the present invention. Here, for facilitation of explanation, there are shown slots and the sequence corresponding to #slot**1** to #slot**12** in FIG. **12**.

In FIG. **13** and FIG. **14**, at #slot**1**, the base station apparatus transmits, to the mobile station apparatus, the RRC signaling including the reception quality information transmittable time region (step S**60**). The mobile station apparatus having received an L1/L2 grant at any slot within the time region (step S**61**) simultaneously transmits the uplink data and the reception quality information (step S**62**). Also at #slot**11**, similar processing is performed (steps S**69**, S**70**). At #slot**3**, the mobile station apparatus having received the L1/L2 grant (step S**63**) transmits the uplink data (step S**64**).

In this example, since it shows that the uplink data and the reception quality information are simultaneously transmitted with respect to the L1/L2 grant first received with the reception quality information transmittable time region, simultaneous transmission is not performed at #slot**3**. Also at #slot**6**, #slot**7** and #slot**12**, similar processing is performed (steps S**65** to S**68**, S**71** and S**72**).

In the third embodiment of the present invention, for facilitation of explanation description has been given in connection with the example where the uplink data and the reception quality information are simultaneously transmitted with respect to the L1/L2 grant first received within the reception quality information transmittable time region. However, the reception quality information may be transmitted at any slot within the reception quality information transmittable time region.

As described above, according to the third embodiment of the present invention, the base station apparatus transmits, to the mobile station apparatus, the RRC signaling that includes the reception quality information transmittable time region, and the mobile station apparatus having received the L1/L2 grant within the time region simultaneously transmits the uplink data and the reception quality information. Thus, the base station apparatus can control the transmission frequency of the reception quality information and can perform the transmission control which flexibly treats the information amount of the reception quality information. Further, the uplink data and the reception quality information can be simultaneously transmitted, which leads to reduction in wasteful use of the resource of the L1/L2 grant.

Moreover, it is possible to perform, more efficiently, the transmission control of the reception quality information without adding information to the L1/L2 grant to be transmitted from the base station apparatus to the mobile station apparatus. Namely, when a transmission instruction of the reception quality information is given at fixed timing using the radio resource control signal (RRC signaling) from the base station apparatus to the mobile station apparatus, if there is a need to give a transmission instruction of the reception quality information dynamically using the uplink data transmission permission signal, it is required to give an instruction at which timing the reception quality information is to be transmitted, using the uplink data transmission permission signal from the base station apparatus to the mobile station apparatus. According to the present invention, since the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data is transmitted to the mobile station apparatus, wasteful use of the resource of the uplink data transmission permission signal is reduced, and thereby the resource can be effectively utilized.

Fourth Embodiment

FIG. **15** is a view showing a control signal transmitted from the base station apparatus to the mobile station apparatus, and the reception quality information, the uplink data which are transmitted from the mobile station apparatus to the base station apparatus, and reception quality information transmission form in the fourth embodiment of the present invention. In FIG. **15**, as an example, there is shown an operation from #slot**1** to #slot**24**. First, the base station apparatus transmits, to the mobile station apparatus, the RRC signaling which includes the resource assignment and the transmission interval when the mobile station apparatus transmits the reception quality information using the PUCCH, and the reception quality information transmittable time region.

In FIG. **15**, it shows that the reception quality information is transmitted using the PUCCH at the transmission interval of five slots, and to set reception quality information transmittable time region at #slot**1** to #slot**4**, #slot**11** to #slot**14** and #slot**21** to #slot**24**. Moreover, it shows that the mobile station apparatus simultaneously transmits the uplink data and the reception quality information with respect to the L1/L2 grant (#slot**3**, #slot**12**, and #slot**23**) first received within the reception quality information transmittable time region.

At #slot**2**, the mobile station apparatus in which the resource assignment and the transmission interval in transmitting the reception quality information using the PUCCH are set by the RRC signaling from the base station apparatus transmits, using the PUCCH, the reception quality information of small information amount in the resource of the PUCCH and at the transmission interval determined at that setting.

At #slot**3**, the mobile station apparatus having received the L1/L2 grant from the base station apparatus simultaneously transmits the uplink data and the reception quality information. While the transmission form in simultaneously transmitting the uplink data and the reception quality information is similar to that shown in the first embodiment, the RRC signaling including the physical format for simultaneous transmission may be transmitted from the base station apparatus.

At #slot**7**, it is shown that the base station apparatus has transmitted the L1/L2 grant at a slot which is set so as to transmit the reception quality information of small informa-

tion amount using the PUCCH. At the #slot**7**, the mobile station apparatus having received the L1/L2 grant from the base station apparatus simultaneously transmits, using the PUSCH, the uplink data and the reception quality information of small information attempting to be transmitted on PUCCH. At this time, as described in the second embodiment, the base station apparatus transmits the L1/L2 grant to thereby recognize in advance that there is no information to be transmitted by the resource of the PUCCH, other mobile station apparatus are performed scheduling so as to transmit the uplink information (e.g., ACK/NACK signal) using the resource.

At #slot**12**, it is shown that the L1/L2 grant is transmitted within the reception quality information transmittable time region at the slot which is set so as to transmit the reception quality information of small information amount using the PUCCH. At the #slot**12**, the mobile station apparatus having received the L1/L2 grant from the base station apparatus simultaneously transmits, using the PUSCH, the uplink data and the reception quality information. Here, as the reception quality information transmitted simultaneously with the uplink data, as described in the second embodiment, it is possible to transmit the reception quality information of large information amount, the reception quality information of small information amount and the reception quality information of large information amount attempting to be transmitted on PUCCH, or the reception quality information of small information amount attempting to be transmitted on PUCCH and the relationship thereof.

FIG. **16** is a view showing content and form to be transmitted in the slot in the fourth embodiment according to the present invention. Moreover, FIG. **17** is a sequence chart showing the operation of the fourth embodiment according to the present invention. Here, for facilitation of explanation, there are shown slots and the sequence corresponding to #slot**1** to #slot**12** in FIG. **15**.

In FIG. **16** and FIG. **17**, at #slot**1**, the base station apparatus transmits the RRC signaling which includes the resource assignment and the transmission interval in transmitting the reception quality information using the PUCCH, and the reception quality information transmittable time region (step S**80**). The mobile station apparatus having received the signal transmits the reception quality information of small information amount in the resource of the PUCCH and at the transmission interval determined by the setting (step S**81**). In addition, in the case of receiving the L1/L2 grant at any slot within the reception quality information transmittable time region (step S**82**), the uplink data and the reception quality information are simultaneously transmitted (step S**83**).

At the #slot**2**, the mobile station apparatus transmits, using the PUCCH, the reception quality information of small information amount. At #slot**3**, the base station apparatus transmits the L1/L2 grant (step S**82**). The mobile station apparatus having received the signal simultaneously transmits the uplink data and reception quality information (step S**83**). At #slot**4**, the base station apparatus transmits the L1/L2 grant (step S**84**). The mobile station apparatus having received the signal transmits the uplink data (step S**85**).

In this example, since it shows that the uplink data and the reception quality information are transmitted simultaneously with respect to the L1/L2 grant received first within the reception quality information transmittable time region, simultaneous transmission is not performed at #slot**4**. At #slot**6** and #slot**9** similar processing is performed (steps S**86**, S**87**, S**90** and S**91**).

At #slot**7**, the base station apparatus transmits the L1/L2 grant (step S**88**) and the mobile station apparatus having received the signal transmits, using the PUSCH, the uplink data and the reception quality information of small information amount attempting to be transmitted on the PUCCH (step S**89**). In addition, the base station apparatus performs scheduling so that other mobile station apparatus can transmit the uplink information using such resource.

At #slot **12**, the base station apparatus transmits the L1/L2 grant (step S**92**) and the mobile station apparatus having received the signal transmits the uplink data and the reception quality information having large information amount, or the uplink data and the reception quality information of small information amount and the reception quality information of large information amount attempting to be transmitted on PUCCH, or the uplink data and the reception quality information of small information amount attempting to be transmitted on PUCCH and the relationship thereof (step S**93**).

In the fourth embodiment, for facilitation of explanation, description has been given in connection with the example to simultaneously transmit the uplink data and the reception quality information with respect to the L1/L2 grant first received within the reception quality information transmittable time region. However, the reception quality information can be transmitted at any slot within the reception quality information transmittable time region.

As described above, according to the fourth embodiment of the present invention, the base station apparatus transmits, to the mobile station apparatus, the RRC signaling including the resource assignment, the transmission interval when the mobile station apparatus transmits the reception quality information using the PUCCH, and the reception quality information transmittable time region. The mobile station apparatus having received the L1/L2 grant within the time region simultaneously transmits the uplink data and the reception quality information so that the base station apparatus can control the transmission frequency of the reception quality information, and can perform the transmission control which flexibly treats the information amount of the reception quality information.

Further, the uplink data and the reception quality information can be transmitted simultaneously, which leads to reduction of wasteful use of the resource of the L1/L2 grant. Namely, when a transmission instruction of the reception quality information is given at a fixed timing using the radio resource control signal (RRC signaling) from the base station apparatus to the mobile station apparatus, if there is a need to give a transmission instruction of the reception quality information dynamically using the uplink data transmission permission signal, it is required to give an instruction at which timing the reception quality information is to be transmitted, using the uplink data transmission permission signal from the base station apparatus to the mobile station apparatus. According to the present invention, since the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data is transmitted to the mobile station apparatus, wasteful use of the resource of the uplink data transmission permission signal is reduced in the downlink, and thereby the resource can be effectively utilized.

In addition, it is possible to perform more efficiently transmission control of the reception quality information without adding information to the L1/L2 grant to be transmitted from the base station apparatus to the mobile apparatus.

While the preferred embodiments of the present invention have been described so far in detail with reference to attached drawings, practical configurations are not limited to these embodiments, design etc., within the range not departing

from the gist of the present invention may be included within the scope as set forth in patent claims.

As described above, the mobile communication system of the present embodiment is directed to a mobile communication system in which the mobile station apparatus measures reception quality of a signal received from the base station apparatus to transmit reception quality information to the base station apparatus wherein the base station apparatus transmits, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data. The mobile station apparatus simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data in case that receiving, from the base station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information.

As stated above, the base station apparatus transmits, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information, and the mobile station apparatus simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data in case that receiving, from the base station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information. Accordingly, the base station apparatus can control the transmission frequency of the reception quality information. Moreover, it is possible to perform the transmission control of the reception quality information in consideration of the uplink resource within a cell. Further, when a transmission instruction of the reception quality information is given at a fixed timing using the radio resource control signal (RRC signaling) from the base station apparatus to the mobile station apparatus, if there is a need to give a transmission instruction of the reception quality information dynamically using the uplink data transmission permission signal, it is required to give an instruction at which timing the reception quality information is to be transmitted, using the uplink data transmission permission signal from the base station apparatus to the mobile station apparatus. According to the present invention, since the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data is transmitted to the mobile station apparatus, wasteful use of the resource of the uplink data transmission permission signal is reduced in the downlink, and thereby the resource can be effectively utilized.

Moreover, the mobile communication system of the present embodiment is directed to a mobile communication system in which a mobile station apparatus measures reception quality of a signal received from the base station apparatus to transmit reception quality information to the base station apparatus, wherein the base station apparatus transmits, to the mobile station apparatus, the radio resource control signal including information instructing the resource assignment and the transmission interval of the reception quality information for the mobile station apparatus to transmit the reception quality information to the base station apparatus using the uplink control channel, and then transmits, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data. The mobile station apparatus periodically transmits, to the base station apparatus, the reception quality information using the uplink control channel according to the instruction included in the radio resource control signal transmitted from the base station apparatus, and simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel in case that receiving, from the base station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information.

As stated above, the base station apparatus transmits, to the mobile station apparatus, the radio resource control signal including information instructing the resource assignment and the transmission interval of the reception quality information for the mobile station apparatus to transmit the reception quality information to the base station apparatus using the uplink control channel, and then transmits, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information. Accordingly, it is possible to control the transmission frequency of the reception quality information. Moreover, it is possible to properly use the uplink control channel and the uplink data channel in transmitting the reception quality information. Accordingly, it becomes possible to perform the transmission control which flexibly treats the information amount of the reception quality information. Further, when a transmission instruction of the reception quality information is given at a fixed timing using the radio resource control signal (RRC signaling) from the base station apparatus to the mobile station apparatus, if there is a need to give a transmission instruction of the reception quality information dynamically using the uplink data transmission permission signal, it is required to give an instruction at which timing the reception quality information is to be transmitted, using the uplink data transmission permission signal from the base station apparatus to the mobile station apparatus. According to the present invention, since the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data is transmitted to the mobile station apparatus, wasteful use of the resource of the uplink data transmission permission signal is reduced in the downlink, and thereby the resource can be effectively utilized.

Moreover, in the mobile communication system of the present embodiment, in case that the base station apparatus transmits, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information at a slot of the downlink corresponding to a slot of the uplink in advance instructed by using the radio resource control information for the mobile station apparatus so as to transmit the reception quality information using the uplink control channel, and the mobile station apparatus receives, from the base station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information, the mobile station apparatus simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel.

As stated above, the mobile station apparatus periodically transmits, to the base station apparatus, the reception quality information using the uplink control channel at a slot of the uplink that the base station apparatus in advance instructed by using the radio resource control information for the mobile station apparatus so as to transmit the reception quality information using the uplink control channel. At the slot of the downlink corresponding to the slot of the uplink, the base

station apparatus transmits, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information, and in case that the mobile station apparatus receives the uplink data transmission permission signal including the simultaneous transmission permission information, the mobile station apparatus simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel. With this configuration, since the base station apparatus transmits the uplink data transmission permission signal including the simultaneous transmission permission information to the mobile station apparatus, it is possible to control the transmission frequency of the reception quality information. Moreover, it is possible to properly use the uplink control channel and the uplink data channel in transmitting the reception quality information. Accordingly, it becomes possible to perform the transmission control which flexibly treats the information amount of the reception quality information. In addition, the mobile station apparatus can simultaneously transmit, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel. Accordingly, the resource of the uplink control channel at that time becomes empty. For this reason the base station apparatus can perform scheduling so that other mobile station apparatus can use the resource of emptied uplink control channel. Thus, it becomes possible to more efficiently use the uplink resource.

Moreover, the mobile communication system of the present embodiment is directed to a mobile communication system in which a mobile station apparatus measures reception quality of a signal received from a base station to transmit the reception quality information to the base station apparatus wherein the base station apparatus transmits, to the mobile station apparatus, the radio resource control signal including information for setting the reception quality information transmittable time during which the mobile station apparatus can simultaneously transmit the reception quality information and the uplink data to the mobile station apparatus. Then, the base station apparatus transmits the uplink data transmission permission signal to the mobile station apparatus, and when the mobile station apparatus receives, from the base station apparatus, the uplink data transmission permission signal within the set reception quality information transmittable time, the mobile station apparatus simultaneously transmits the reception quality information and the uplink data to the base station apparatus.

As stated above, when the base station apparatus transmits the radio resource control signal including information for setting the reception quality information transmittable time to the mobile apparatus and then transmits the uplink data transmission permission signal to the mobile station apparatus, and the mobile station apparatus receives, from the base station apparatus, the uplink data transmission permission signal within the reception quality information transmittable time, since the mobile station apparatus simultaneously transmits the reception quality information and the uplink data to the base station apparatus, the base station apparatus can control the transmission frequency of the reception quality information. Moreover, since there is no need to add the simultaneous transmission permission information which instructs the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data, in the uplink data transmission permission signal transmitted from the base station apparatus to the mobile station apparatus, it is possible to more efficiently perform the transmission control of the reception quality information. Further, when a transmission instruction of the reception quality information is given at a fixed timing using the radio resource control signal (RRC signaling) from the base station apparatus to the mobile station apparatus, if there is a need to give a transmission instruction of the reception quality information dynamically using the uplink data transmission permission signal, it is required to give an instruction at which timing the reception quality information is to be transmitted, using the uplink data transmission permission signal from the base station apparatus to the mobile station apparatus. According to the present invention, since the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data is transmitted to the mobile station apparatus, wasteful use of the resource of the uplink data transmission permission signal is reduced in the downlink, and thereby the resource can be effectively utilized.

In addition, the mobile communication system of the present embodiment is directed to a mobile communication system in which a mobile station apparatus measures reception quality of a signal received from the base station apparatus to transmit reception quality information to the base station apparatus, wherein the base station apparatus transmits, to the mobile station apparatus, the radio resource control signal including information instructing the resource assignment and the transmission interval of the reception quality information for the mobile station apparatus to transmit the reception quality information using the uplink control channel, and information for setting the reception quality information transmittable time during which the mobile station apparatus can simultaneously transmit the reception quality information and the uplink data, and then transmits the uplink data transmission permission signal to the mobile station apparatus. The mobile station apparatus periodically transmits, to the base station apparatus, the reception quality information using the uplink control channel according to the instruction included in the radio resource control signal transmitted from the base station apparatus, and simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel.

As stated above, the base station apparatus transmits, to the mobile station apparatus, the radio resource control signal including information instructing the resource assignment and the transmission interval of the reception quality information for the mobile station apparatus to transmit the reception quality information using the uplink control channel, and information for setting the reception quality information transmittable time during which the mobile station apparatus can simultaneously transmit the reception quality information and the uplink data, and then transmits the uplink data transmission permission signal to the mobile station apparatus. The mobile station apparatus simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data in case that receiving, from the base station apparatus, the uplink data transmission permission signal within the reception quality information transmittable time. Accordingly, the base station apparatus can control the transmission frequency of the reception quality information. Moreover, it is not required to add the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data in the uplink data transmission permission signal transmitted from the base station apparatus to the mobile station apparatus. Accordingly, it is possible to more efficiently perform the transmission control of the reception quality information. Further, when a transmission instruction of the reception quality information is given

at a fixed timing using the radio resource control signal (RRC signaling) from the base station apparatus to the mobile station apparatus, if there is a need to give a transmission instruction of the reception quality information dynamically using the uplink data transmission permission signal, it is required to give an instruction at which timing the reception quality information is to be transmitted, using the uplink data transmission permission signal from the base station apparatus to the mobile station apparatus. According to the present invention, since the uplink data transmission permission signal including the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data is transmitted to the mobile station apparatus, wasteful use of the resource of the uplink data transmission permission signal is reduced in the downlink, and thereby the resource can be effectively utilized.

In addition, in the mobile communication system of the present embodiment, in case that the base station apparatus transmits, to the mobile station apparatus, the uplink data transmission permission signal at a slot of the downlink corresponding to a slot of the uplink in advance instructed by using the radio resource control information for the mobile station apparatus so as to transmit the reception quality information using the uplink control channel, and the mobile station apparatus receives, from the base station apparatus, the uplink data transmission permission signal, the mobile station apparatus simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel.

As stated above, the mobile station apparatus periodically transmits, to the base station apparatus, the reception quality information using the uplink control channel at a slot of the uplink in advance instructed by using the radio resource control information for the mobile station apparatus so as to transmit reception quality information using the uplink control channel. At the slot of the downlink corresponding to the slot of the uplink, the base station apparatus transmits, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information, and the mobile station apparatus simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel. With this configuration, since the base station apparatus transmits the uplink data transmission permission signal including the simultaneous transmission permission information to the mobile station apparatus, it is possible to control the transmission frequency of the reception quality information. Moreover, since it is possible to properly use the uplink control channel and the uplink data channel in transmitting the reception quality information, it becomes possible to perform the transmission control which flexibly treats the information amount of the reception quality information. Further, since the mobile station apparatus simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel, the resource of the uplink control channel at that time becomes empty. For this reason, the base station apparatus can perform scheduling so that other mobile station apparatus can use the resource of empty uplink control channel. Thus, it becomes possible to more efficiently use the uplink resource.

Moreover, in the mobile communication system of the present embodiment, the base station apparatus transmits, to the mobile station apparatus, the radio resource control signal including information for specifying the physical format when the mobile station apparatus simultaneously transmits the reception quality information and the uplink data, and the mobile station apparatus simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data according to the specified physical format.

As stated above, since the base station apparatus transmits, to the mobile station apparatus, the radio resource control signal including information for specifying the physical format when the mobile station apparatus simultaneously transmits the reception quality information and the uplink data, it becomes possible to control, on the base station apparatus side, the physical format when the mobile station apparatus simultaneously transmits the reception quality information and the uplink data.

Further, the base station apparatus of the present embodiment is directed to a base station apparatus for controlling transmission operation of reception quality information with respect to the mobile station apparatus, and includes: a scheduler unit that receives the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data generated by the mobile station apparatus, and the uplink data transmission permission signal, and performs scheduling to include the simultaneous transmission permission information into the uplink data transmission permission signal; and a transmission unit for transmitting, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information.

As stated above, since the base station apparatus of the present embodiment transmits the uplink data transmission permission signal including the simultaneous transmission permission information to the mobile station apparatus, it is possible to control the transmission frequency of the reception quality information on the base station apparatus side. Moreover, it becomes possible to perform the transmission control of the reception quality information in consideration of the uplink resource within a cell.

Further, the base station apparatus of the present embodiment is directed to a base station apparatus for controlling the transmission operation of reception quality information with respect to the mobile station apparatus, includes: a scheduler unit that receives information instructing the resource assignment and the transmission interval of the reception quality information for the mobile station apparatus to transmit the reception quality information using the uplink control channel, and the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data generated by the mobile station apparatus, and the uplink data transmission permission signal, performs scheduling to include information for instructing the resource assignment and the transmission interval of the reception quality information for the mobile station apparatus to the transmit reception quality information using the uplink control channel, into the radio resource control signal, and also performs scheduling to include the simultaneous transmission permission information into the uplink data transmission permission signal; and a transmission unit for transmitting, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information after transmitting the radio resource control signal to the mobile station apparatus.

As stated above, the base station apparatus of the embodiment transmits, to the mobile station apparatus, the radio resource control signal including information instructing the resource assignment and the transmission interval of the reception quality information for the mobile station apparatus

to transmit the reception quality information using the uplink control channel, and thereafter transmits the uplink data transmission permission signal including the simultaneous transmission permission information to the mobile station apparatus. Accordingly, it is possible to control the transmission frequency of the reception quality information. In addition, since it is possible to properly use the uplink control channel and the uplink data channel in transmitting the reception quality information, it becomes possible to perform the transmission control which flexibly treats the information amount of the reception quality information.

In addition, in the base station apparatus of the present embodiment, the scheduler unit performs scheduling for transmitting the uplink data transmission permission signal including the simultaneous transmission permission information to the mobile station apparatus at a slot of the downlink corresponding to a slot of the uplink in advance instructed by using the radio resource control information for the mobile station apparatus so as to transmit reception quality information using the uplink control channel.

As stated above, the base station apparatus of the present embodiments transmits, to the mobile station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information at a slot of the downlink corresponding to a slot of the uplink. Accordingly, it is possible to control the transmission frequency of the reception quality information. Moreover, since it is possible to properly use the uplink control channel and the uplink data channel in transmitting the reception quality information, it becomes possible to perform the transmission control which flexibly treats the information amount of the reception quality information. Further, since the reception quality information and the uplink data are simultaneously transmitted to the base station apparatus using the uplink data channel with respect to the mobile station apparatus, the resource of the uplink control channel at that time becomes empty. For this reason, the base station apparatus can perform scheduling so that other mobile station apparatus can use the resource of empty uplink control channel. Thus, it is possible to more efficiently use the uplink resource.

In addition, the base station apparatus of the present embodiment is directed to a base station apparatus for controlling transmission operation of reception quality information, and includes: a scheduler unit that receives information for setting the reception quality information transmittable time during which the mobile station apparatus can simultaneously transmit the reception quality information and the uplink data, and the uplink data transmission permission signal, and performs scheduling to include the information for setting the reception quality information transmittable time into the radio resource control signal; and a transmission unit for transmitting the uplink data transmission permission signal to the mobile station apparatus after transmitting the radio resource control signal.

As stated above, the base station apparatus of the present embodiment transmits the radio resource control signal including information for setting the reception quality information transmittable time to the mobile station apparatus, and thereafter transmits the uplink data transmission permission signal to the mobile station apparatus. Accordingly, it is possible to control the transmission frequency of the reception quality information. Further, since it is not required to add the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data in the uplink data transmission permission signal transmitted from the base station apparatus to the mobile station apparatus, it is possible to more efficiently perform the transmission control of the reception quality information.

Further, the base station apparatus of this embodiment is directed to a base station apparatus for controlling transmission operation of reception quality information with respect to the mobile station apparatus, and includes: a scheduler unit that receives first information instructing the resource assignment and the transmission interval of the reception quality information for the mobile station apparatus to transmit the reception quality information using the uplink control channel, second information for setting the reception quality information transmittable time during which the mobile station apparatus can simultaneously transmit the reception quality information and the uplink data, and the uplink data transmission permission signal, and performs scheduling to include the first and second information into the radio resource control signal; and a transmission unit for transmitting the uplink data transmission permission signal to the mobile station apparatus after transmitting the radio resource control signal.

As stated above, the base station apparatus of the present embodiment transmits the radio resource control signal including the first and second information to the mobile station apparatus, and thereafter transmits the uplink data transmission permission signal to the mobile station apparatus. Accordingly, it is possible to control the transmission frequency of the reception quality information. Moreover, since it is not required to add the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data in the uplink data transmission permission signal transmitted from the base station apparatus to the mobile station apparatus. Accordingly, it is possible to more efficiently perform the transmission control of the reception quality information.

Further, in the base station apparatus of the present embodiment, the scheduler unit performs scheduling for transmitting the uplink data transmission permission signal to the mobile station apparatus at a slot of the downlink corresponding to a slot of the uplink in advance instructed by using the radio resource control information for the mobile station apparatus so as to transmit the reception quality information.

According to the base station apparatus of the present embodiment, since the uplink data transmission permission signal including the simultaneous transmission permission information is transmitted to a mobile station apparatus, it is possible to control the transmission frequency of the reception quality information. Moreover, since it is possible to properly use the uplink control channel and the uplink data channel in transmitting the reception quality information, it is possible to perform the transmission control which flexibly treats the information amount of the reception quality information. Further, since the mobile station apparatus simultaneously transmits the reception quality information and the uplink data to the base station apparatus, the resource of the uplink control channel at that time becomes empty. For this reason, the base station apparatus can perform scheduling so that other mobile station apparatus can use the resource of emptied uplink control channel. Thus, it is possible to more efficiently use the uplink resource.

In addition, in the base station apparatus of the present embodiment, the scheduler unit performs scheduling for including into the radio resource control signal, information for specifying the physical format when the mobile station apparatus simultaneously transmits the reception quality information and the uplink data, and the transmission unit

transmits, to the mobile station apparatus, the radio resource control signal including information for specifying the physical format.

As stated above, the base station apparatus of the present embodiment transmits, to the mobile station apparatus, the radio resource control signal including information for specifying the physical format when the mobile station apparatus simultaneously transmits the reception quality information and the uplink data. Accordingly, it becomes possible to control, on the base station apparatus side, the physical format when the mobile station apparatus simultaneously transmits the reception quality information and the uplink data.

Moreover, the mobile station apparatus of the present embodiment is directed to a mobile station apparatus that measures reception quality of a signal received from a base station apparatus to transmit reception quality information to the base station apparatus, and includes: a reception unit for receiving, from the base station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information for giving an instruction to simultaneously transmit the reception quality information and the uplink data; and a transmission unit for simultaneously transmitting, to the base station apparatus, the reception quality information and the uplink data in case that the reception unit receives the uplink data transmission permission signal including the simultaneous transmission permission information.

As stated above, the mobile station apparatus of this embodiment, in case that receiving the uplink data transmission permission signal including the simultaneous transmission permission information from the base station apparatus, simultaneously transmits the reception quality information and the uplink data to the base station apparatus so that the transmission frequency of the reception quality information can be controlled on the base station apparatus side. In addition, it is possible to perform the transmission control of the reception quality information in consideration of the uplink resource within a cell.

Moreover, the mobile station apparatus of the present embodiment is directed to a mobile station apparatus that measures reception quality of a signal received from a base station apparatus to transmit reception quality information to the base station apparatus, and includes: a reception unit for receiving, from the base station apparatus, the radio resource control signal including information instructing the resource assignment and the transmission interval of the reception quality information for transmitting the reception quality information to the base station apparatus using the uplink control channel, and thereafter receiving the uplink data transmission permission signal including the simultaneous transmission permission information for giving an instruction to simultaneously transmit the reception quality information and the uplink data; and a transmission unit for periodically transmitting, to the base station apparatus, the reception quality information using the uplink control channel, according to an instruction included in the radio resource control signal, and for simultaneously transmitting, in case that the reception unit receives, from the base station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information, the reception quality information and the uplink data using the uplink data channel to the base station apparatus.

As stated above, the mobile station apparatus of the present embodiment, after receiving the radio resource control signal including information instructing the resource assignment and the transmission interval of the reception quality information for transmitting, to the base station apparatus, the reception quality information using the uplink control channel, receives the uplink data transmission permission signal including the simultaneous transmission permission information for giving an instruction to simultaneously transmit the reception quality information and the uplink data. Accordingly, it is possible to control the transmission frequency of the reception quality information on the base station apparatus side. In addition, since it is possible to properly use the uplink control channel and the uplink data channel in transmitting the reception quality information, it is possible to perform the transmission control which flexibly treats the information amount of the reception quality information.

Moreover, in the mobile station apparatus of the present embodiment, the reception unit receives, from the base station apparatus, the uplink data transmission permission signal including the simultaneous transmission permission information at a slot of the downlink corresponding to a slot of the uplink which the base station apparatus in advance instructs by using the radio resource control information so as to transmit the reception quality information using the uplink control channel, the transmission unit simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel.

According to the mobile station apparatus of the present embodiment, it is possible to properly use the uplink control channel and the uplink data channel in transmitting the reception quality information. Accordingly, it becomes possible to perform the transmission control which flexibly treats the information amount of the reception quality information. Moreover, since the reception quality information and the uplink data are simultaneously transmitted to the base station apparatus using the uplink data channel, the resource of the uplink control channel at that time becomes empty. For this reason, the base station apparatus can perform scheduling so that other mobile station apparatus can use the resource of empty uplink control channel. Thus, it becomes possible to use the uplink resource more efficiently.

Further, the mobile station apparatus of the present embodiment is directed to a mobile station apparatus that measures reception quality of a signal received from a base station apparatus to transmit reception quality information to the base station apparatus, and includes: a reception unit for receiving, from the base station apparatus, the radio resource control signal including information for setting the reception quality information transmittable time during which the reception quality information and the uplink data can be simultaneously transmitted, and thereafter receiving the uplink data transmission permission signal; and a transmission unit for simultaneously transmitting, to the base station apparatus, the reception quality information and the uplink data.

As states above, the mobile station apparatus of the present embodiment, in case that receiving the uplink data transmission permission signal from the base station apparatus within the reception quality information transmittable time, simultaneously transmits the reception quality information and the uplink data to the base station apparatus. Accordingly, it is possible to control the transmission frequency of the reception quality information on the base station apparatus side. Moreover, with this configuration, there is no necessity to add the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data in the uplink data transmission permission signal to be transmitted from the base station apparatus to the mobile station

apparatus. Accordingly, it is possible to perform more efficiently transmission control of the reception quality information.

In addition, the mobile station apparatus of the present embodiment is directed to a mobile station apparatus that measures reception quality of a signal received from a base station apparatus to transmit reception quality information to the base station apparatus, and includes: a reception unit for receiving the radio resource control signal including information instructing the resource assignment and the transmission interval of the reception quality information for transmitting the reception quality information using the uplink control channel and information for setting the reception quality information transmittable time during which the reception quality information and the uplink data can be simultaneously transmitted, and thereafter receiving the uplink data transmission permission signal; and a transmission unit for periodically transmitting, to the base station apparatus, the reception quality information using the uplink control channel according to the instruction included in the radio resource control signal, and simultaneously transmitting, in case that receiving the uplink data transmission permission signal from the base station apparatus, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel.

As stated above, since the mobile station apparatus of the present embodiment, in case that receiving the uplink data transmission permission signal from a base station apparatus within the reception quality information transmittable time, simultaneously transmits the reception quality information and the uplink data to the base station apparatus, it is possible to control the transmission frequency of the reception quality information on the base station apparatus side. Moreover, since there is no need to add the simultaneous transmission permission information for instructing the mobile station apparatus to simultaneously transmit the reception quality information and the uplink data in the uplink data transmission permission signal transmitted from the base station apparatus to the mobile station apparatus, it is possible to perform more efficiently transmission control of the reception quality information.

Moreover, in the mobile station apparatus of this embodiment, the reception unit receives the uplink data transmission permission signal from the base station apparatus at a slot of the downlink corresponding to a slot of the uplink that the base station apparatus in advance instructs by using the radio resource control information so as to transmit the reception quality information using the uplink control channel, the transmission unit simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data using the uplink data channel.

According to the mobile station apparatus of the present embodiment, it is possible to control the transmission frequency of the reception quality information on the base station apparatus side. Moreover, since it is possible to properly use the uplink control channel and the uplink data channel in transmitting the reception quality information, it becomes possible to perform transmission control which flexibly treats the information amount of the reception quality information in the base station apparatus. Further, since the reception quality information and the uplink data are simultaneously transmitted to the base station apparatus using the uplink data channel, the resource of the uplink control channel at that time becomes empty. For this reason, the base station apparatus can perform scheduling so that other mobile station apparatus can use the resource of empty uplink control channel. Thus, it becomes possible to more efficiently use the uplink resource.

In addition, in the mobile station apparatus of this embodiment, the reception unit receives, from the base station apparatus, the radio resource control signal including information for specifying the physical format in simultaneously transmitting the reception quality information and the uplink data, and the transmission unit simultaneously transmits, to the base station apparatus, the reception quality information and the uplink data according to the specified physical format.

As described above, the mobile station apparatus of the present embodiment, receives the radio resource control signal including information for specifying the physical format in simultaneously transmitting the reception quality information and the uplink data from the base station apparatus. Accordingly, it becomes possible to control, on the base station apparatus side, the physical format in simultaneously transmitting the reception quality information and the uplink data.

The invention claimed is:

1. A mobile communication system in which a mobile station apparatus transmits, to a base station apparatus, uplink data using a physical uplink shared channel assigned by an uplink data transmission permission signal,

wherein said base station apparatus:

transmits, to said mobile station apparatus, a radio resource control signal including a first instruction to periodically transmit a first reception quality information; and

transmits, to said mobile station apparatus, said uplink data transmission permission signal, and

wherein said mobile station apparatus:

periodically transmits, to said base station apparatus, said first reception quality information according to said first instruction to periodically transmit said first reception quality information included in said radio resource control signal;

transmits, to said base station apparatus, a second reception quality information using said physical uplink shared channel in a case wherein a second instruction to transmit said second reception quality information is included in said uplink data transmission permission signal; wherein

said first reception quality information is transmitted, to said base station apparatus, by said mobiles station apparatus using a physical uplink control channel in a case wherein said physical uplink shared channel is not assigned,

said first reception quality information is transmitted, to said base station apparatus, by said mobile station apparatus using said physical uplink shared channel in a case wherein said physical uplink shared channel is assigned by said uplink data transmission permission signal without said second instruction to transmit said second reception quality information, and

said first reception quality information and said second reception quality information are selectively transmitted, to said base station apparatus, by said mobile station apparatus.

2. The mobile communication system according to claim **1**,

wherein said first reception quality information transmitted using said physical uplink shared channel has a form in which said first reception quality information is transmitted using said physical uplink control channel.

3. A mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a

base station apparatus, uplink data using a physical uplink shared channel assigned by an uplink data transmission permission signal,

said mobile station apparatus comprising:

an unit which receives, from said base station apparatus, a radio resource control signal including a first instruction to periodically transmit a first reception quality information;

an unit which receives, from said base station apparatus, said uplink data transmission permission signal;

an unit which periodically transmits, to said base station apparatus, said first reception quality information according to said first instruction to periodically transmit said first reception quality information included in said radio resource control signal;

an unit which transmits, to said base station apparatus, a second reception quality information using said physical uplink shared channel in a case wherein a second instruction to transmit said second reception quality information is included in said uplink data transmission permission signal; wherein

said first reception quality information is transmitted, to said base station apparatus, by said mobiles station apparatus using a physical uplink control channel in a case wherein said physical uplink shared channel is not assigned;

said first reception quality information is transmitted, to said base station apparatus, by said mobile station apparatus using said physical uplink shared channel in a case wherein said physical uplink shared channel is assigned by said uplink data transmission permission signal without said second instruction to transmit said second reception quality information, and

said first reception quality information and said second reception quality information are selectively transmitted, to said base station apparatus, by said mobile station apparatus.

4. The mobile station apparatus according to claim **3**,

wherein said first reception quality information transmitted using said physical uplink shared channel has a form in which said first reception quality information is transmitted using said physical uplink control channel.

5. A communication method of a mobile station apparatus in a mobile communication system in which said mobile station apparatus transmits, to a base station apparatus, uplink data using a physical uplink shared channel assigned by an uplink data transmission permission signal,

said communication method comprising:

receiving, from said base station apparatus, a radio resource control signal including a first instruction to periodically transmit a first reception quality information;

receiving, from said base station apparatus, said uplink data transmission permission signal;

periodically transmitting, to said base station apparatus, said first reception quality information according to said first instruction to periodically transmit said first reception quality information included in said radio resource control signal;

transmitting, to said base station apparatus, a second reception quality information using said physical uplink shared channel in a case wherein a second instruction to transmit said second reception quality information is included in said uplink data transmission permission signal; wherein

said first reception quality information is transmitted, to said base station apparatus, by said mobiles station apparatus using a physical uplink control channel in a case wherein said physical uplink shared channel is not assigned;

said first reception quality information is transmitted, to said base station apparatus, by said mobile station apparatus using said physical uplink shared channel in a case wherein said physical uplink shared channel is assigned by said uplink data transmission permission signal without said second instruction to transmit said second reception quality information, and

said first reception quality information and said second reception quality information are selectively transmitted, to said base station apparatus, by said mobile station apparatus.

6. The communication method according to claim **5**,

wherein said first reception quality information transmitted using said physical uplink shared channel has a form in which said first reception quality information is transmitted using said physical uplink control channel.

* * * * *